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THE INTRAMUSCULAR ADMINISTRATION OF SODIUM CITRATE A NEW METHOD FOR THE CONTROL OF BLEEDING

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UPON the clinical application of the anticoagulating action of sodium citrate to blood transfusion, in 1915, there immediately arose the question of the effect of sodium citrate on the coagulability of the recipient's blood. Would the introduction of sodium citrate, recognized as an anticoagulant, result in a suspension of coagulation in the recipient? That this did not occur was soon established; in fact, a transient shortening of the coagulation time in the recipient, with a subsequent return to the previous level, was found to follow the transfusion of citrated blood. In an effort to seek an explanation for this paradoxical action, some experiments were begun by Neuhof in 1916 and again taken up in 1919 by both authors.

The experiments, consisting in the intravenous injection of solutions of sodium citrate, were performed on dogs under ether anæsthesia. They will be detailed in another publication. In brief they established the following hitherto undescribed results of the administration of sodium citrate: 1. The coagulation time is tremendously shortened within a few minutes of the introduction of non-toxic doses of sodium citrate, and this shortened coagulation time may be sustained for one or more days. 2. The bleeding time is likewise shortened so that, after citrate injection, a large vessel can be incised with prompt coagulation about the wound in the vessel. 3. Coincident with the shortened coagulation time the color of the venous blood is altered to a light arterial tint. 4. There is no fixed toxic or lethal dose of sodium citrate per kilogram of body weight, toxicity depending to a remarkable degree upon the rate of introduction of the citrate solution. 5. A toxic or lethal dose is characterized by a swing from the state of shortened coagulation time to one of suspended coagulation (incoagulability of the blood). We have therefore demonstrated that the pharmacological action of sodium citrate is not the universally accepted one of anticoagulation. On the contrary, intravenous administration of the drug shortens coagulation time. Only an

excess dose for a given bulk of blood will result in a suspension of coagulation. The latter phenomenon, universally used in the laboratory, led to the sodium citrate method of blood transfusion. It was this effect of an excess dose that overshadowed the ordinary pharmacological action of sodium citrate.

Few and incomplete observations have been made on the effect of the intravenous administration of sodium citrate in the human being. Weil[1] reported the effect of five grams of a twenty per cent. solution given to an adult. The coagulation time was shortened by half; no other data were given. In a case of hæmophilia described by Ottenberg[2] a minute dose (six-tenths of a gram) was followed by a marked drop in coagulation time with a subsequent prolongation of coagulation time as noted forty-eight hours later. Kinsella and Brown[3] reported an attempt to control the hemorrhagic manifestations in the lungs in influenza by the intravenous introduction of sodium citrate in one-gram doses and described effects on coagulation time in five patients. From none of these reports can one gain any idea of the duration of the changed coagulation time following citrate injections except in the case of hæmophilia. In all, with the single exception of Weil's case, very small doses were employed. We have been unable to find observations in the literature on the possible effects of large doses of sodium citrate on bleeding.

Our clinical studies, based on the experimental observations we have made, were begun about two and a half years ago. Sodium citrate has been administered by one route or another in about 500 cases and this report is based on observations made upon these patients. Small doses were at first employed. The effects from these being transient and uncertain, progressively increasing doses were administered in varying concentrations until the dosage for the desired action on coagulation and bleeding time was determined.

Preparation and Concentration of the Solution.—The solution is prepared by dissolving U.S.P. sodium citrate in distilled water, filtering if necessary. It is then sterilized in an autoclave. Unless clear the solution should not be used. We now employ a thirty per cent. solution. As a result of experimentation with various doses we have established a dose of nine grams for adults (thirty c.c. of the thirty per cent. solution) as the optimal dose for intramuscular use, six grams for intravenous introduction. The dose for infants and children is proportionate to the age and weight.

Intravenous Administration.—The results were reported in an earlier publication.[4] In a series of two hundred cases no untoward effects were noted when the sodium citrate solution was slowly introduced with the technic we employed. The effects on coagulation and bleeding time, to be noted below, were regularly obtained. We emphasized the necessity for the slow and intermittent introduction of the drug, pointing to the dangers of its rapid administration as noted in our animal experiments. A fatality in another's hands ensued in a case in which this precaution was not observed. This led us to investigate other methods of administration of sodium citrate

in an effort to determine if the desired effect could be obtained without the danger inherent in a careless intravenous injection of the drug.

Some interesting results followed the *oral* and *rectal* administration of very large doses of sodium citrate in a few cases, but these will not be reported here. The effects of the drug given by these routes proved too slow and uncertain for ordinary use. *Subcutaneously* given the effect of sodium citrate was very similar to that of the intravenous method. Marked local infiltration and pain at the site of injection occurred frequently, however, and the subcutaneous use of the drug had to be abandoned for this reason.

Intramuscular Administration.—This method has proven satisfactory and free from danger. The results obtained closely parallel those after intravenous injection. The method is of course simpler and the precaution of slow administration is unnecessary. The intramuscular method has therefore superseded the intravenous and other methods and is the only one we have employed in the last 200 cases. We would reserve the intravenous method for cases in which very prompt action is desired. The injection is given into the gluteal muscles. The introduction of thirty c.c. of a thirty per cent. solution of sodium citrate into one buttock was found to be very painful and weaker concentrations were tried without much improvement in this respect. Upon dividing the dose, fifteen c.c. in each buttock, the injection was not so painful, yet left much to be desired. We then found that a preliminary injection of novocaine before the introduction of the sodium citrate solution renders the method much less painful. The technic we now employ is as follows: Two four-inch needles are used, one for each buttock. With the needles inserted directly into the gluteal muscles three to four c.c. of a one per cent. solution of novocaine are introduced into each. Full time is allowed for the novocaine to act; that is, three or four minutes. The thirty per cent. sodium citrate solution is now injected, fifteen c.c. into each buttock. This method is not painless, but the discomfort is usually transient. There is no late infiltration. Two infections followed in the series of about 200 cases, but these may be attributed to errors in asepsis.

The Effects of the Administration of Sodium Citrate. Changes in Coagulation Time.—A typical curve after a dose of six grams, given *intravenously* in a patient having a coagulation time of ten minutes, may be described as follows: Five minutes after the injection the coagulation time drops to seven minutes, ten minutes later it reaches five minutes, in one-half hour the coagulation time is between two and three minutes. The peak is reached some forty minutes after the injection, and is sustained in the neighborhood of a two-minute coagulation time for an additional hour. The return to normal then begins, but this is much more gradual than the rapid drop after injection. In six hours the coagulation time reaches five minutes. Twelve hours after the injection it is still about seven minutes. The return to normal occurs after a variable time; in most instances the normal is reached in twenty-four hours, but occasionally not until forty-eight hours or longer after the administration of the drug. The reaction after *subcutaneous* administration is very

similar. The peak is not reached for an hour but is sustained for a much more prolonged period with a more gradual return to normal in from forty-eight to seventy-two hours. After *intramuscular* injections the results are almost identical with the subcutaneous method, the peak of the reaction occurring in about three-quarters of an hour, maintained for from one to three hours and usually returning to the normal within forty-eight hours. These curves are typical and figures closely approximating those we have given were obtained in all instances in which frequent observations were possible.

Of noteworthy interest is the fact that the coagulation time is shortened to a similarly striking degree in patients in whom it was pathologically prolonged, especially in jaundice. We have noted, for example, a drop from sixteen to two minutes. The curve was not observed, however, in the few patients suffering from blood diseases in whom we have had the opportunity to administer the drug.

Changes in the Color of the Blood.—The change in the color of the venous blood to a light arterial tint is usually present shortly after the introduction of the citrate solution. The return to the normal hue of venous blood is noted as the coagulation time again approaches that existing before the injection. In the few cases in which the coagulation reaction did not occur no change in the color of the blood was noted and we therefore regard this alteration in color as a characteristic element in the reaction. The appearance is that of venous blood that has been oxidized. Examinations made before and after citrate injections of the hæmoglobin, red blood-cell count, oxygen content of the blood, CO_2 content, and total calcium content, as well as spectroscopic examinations, have revealed no changes, and we are therefore unable to account for the phenomenon at the present time.

Consistency of the Clot.—Concerning the clot that forms in the test tube or at the mouth of the injured vessel, there is every reason to believe that it is at least as solid after citrate injections as before. In fact, we have gained the impression that a tougher and more solid coagulum results from the introduction of the citrate. The best demonstration of the adequacy of the clot is, as will be shown, the permanent cessation of bleeding in the great majority of instances in which sodium citrate was used for this purpose. There was no evidence of intravascular clotting in any of our experiments, and in none of the patients to whom citrate was given was there any suggestion of thrombosis or of embolism.

Manifestations After the Injection of Large Doses of Sodium Citrate.—No manifestations other than local pain have ever occurred after the intramuscular injection of sodium citrate. The following have been noted occasionally after intravenous administration: trembling of the lips, tingling sensations in the fingers and toes, dizziness, nausea, or a sense of oppression and tightness across the chest and abdomen. There have been no untoward after-effects. No chills or elevation of temperature referable to the adminis-

tration of the drug were ever observed. No alteration in blood-pressure has been noted either during or after the introduction of the drug. Sodium citrate is said to have a toxic effect on the kidneys, but we have been unable to verify this clinically even when very large doses were given. Not even a diuretic effect was noted in carefully controlled studies. Up to the present the drug has been administered to two patients suffering from severe nephritis, without untoward manifestations. In short, we wish to emphasize the fact that no evidence of toxicity occurred with any of the large doses given, even though ten to fourteen grams have been administered in a number of instances.

For a period of about six months almost every patient admitted to the surgical service received citrate injections and the pronounced change in coagulation time was seen in nearly every instance, regardless of the disease from which the patient was suffering. The coagulation reaction following citrate administered in optimum doses did not occur in a very few patients. The conditions from which the patients suffered offered no explanation for the absence of the reaction. There were also three patients with cirrhosis of the liver and jaundice in whom the drop in coagulation time did not occur.

There are some cases in which a more prolonged effect is desired than that obtained from a single dose of citrate. We have attempted to sustain the shortened coagulation time by repeating the dose and have in some instances given the drug to patients four or five times within a period of a few weeks. Untoward effects were not noted. A sustained shortened coagulation time could not be maintained for more than four or five days.

Nature of the Reaction. Contra-indications to the Use of Sodium Citrate. Studies in blood chemistry, including oxygen and CO_2 content and total calcium content, kindly carried out by Dr. Jerome Cohen, have shown that no changes occur as a result of the introduction of sodium citrate. Red blood-cell counts, hæmoglobin and spectroscopic examinations, have not shown changes. In a personal communication from Doctors Baehr and Rosenthal, who have studied many of our specimens of blood after citrate injections, we learn that they have determined that the action of sodium citrate is on the blood platelets. The platelets are destroyed with the consequent liberation of an excessive amount of a substance activating coagulation. It is therefore clear that in those diseases of the blood in which there is a platelet deficiency, notably in hæmophilia and purpura, the use of sodium citrate for the control of bleeding would be contraindicated. Before their studies were made we observed two cases of hæmophilia, one through the courtesy of Doctor Ottenberg, in which sodium citrate was administered in large doses. In both there was a slight primary drop in coagulation time with a marked secondary prolongation far beyond the original coagulation time. We have also had three cases of purpura and have noted results similar to those obtained in hæmophilia except that there was no primary drop in coagulation time but an immediate and continued prolongation. These few clinical observations strongly support the view held by Baehr and Rosenthal,

and we therefore feel that blood diseases are a clear contraindication to the use of sodium citrate. They also comprise the sole contraindication as far as our observations have gone.

The Effect of Sodium Citrate on Bleeding.—The evidence of the striking and sometimes remarkable effects of large doses of sodium citrate on bleeding in human beings rests on purely clinical observations. It can truly be said that bleeding would have ceased spontaneously in some, if not many, of the cases we have studied. Up to the present time, however, bleeding has been checked within an hour in the great majority of cases in which the citrate injection has been given for that purpose and the results can therefore be fairly attributed to the use of the drug.

Unless the underlying cause of a hemorrhage is cared for, recurrence of bleeding may of course take place, for the sodium citrate is only employed for the immediate control of hemorrhage. For example, a patient suffering from an incomplete abortion had been bleeding continuously for several days; bleeding stopped for twelve hours after the injection and then recurred and continued until the uterus was emptied. There were three cases in which hemorrhage controlled by sodium citrate recurred after various periods of time, to be permanently controlled by a second dose of the drug. These were a case of hemorrhage from a colostomy wound for carcinoma of the rectum, one of hemorrhage from the abdominal wall after an exploratory laparotomy for carcinoma in a jaundiced patient, and a case of polycythæmia with bleeding from the gums after the extraction of several teeth.

In all the remaining cases a single dose of sodium citrate permanently controlled the hemorrhage. The evidence of the control of bleeding of course varied with the nature of the case. In some instances it was obtained by operation, in some by aspiration, and in others by inspection or examination of vomitus, stool, etc. The clinical course alone established the evidence of cessation of bleeding in a number of instances. Case reports cannot be detailed in this publication. The cases fall into four groups:

Internal Hemorrhage.—Bleeding was controlled in cases of hæmatemesis, traumatic rupture of the liver, traumatic hæmothorax, hæmoptysis, and possibly in a case of cerebral hemorrhage.

External Hemorrhage.—These cases were varied. They include lacerated wounds, areas left bare by operation, post-operative hemorrhages from the rectum, the prostatic bed, and after operations on the common bile duct, and compound fractures.

Bleeding Encountered at Operation.—There were a number of impressive examples at cranial, abdominal, and other operations. One instance may be mentioned, a case that proved to be cirrhosis of the liver with icterus. The injection of sodium citrate was begun as the abdominal incision was made. In exploring the under surface of the liver an alarming hemorrhage was started. Packings failed to control this and the bleeding point or area could not be exposed. Without any other measure being employed, the

bleeding quite suddenly became less and ceased soon after. The excess blood was sponged away and the operation continued without further bleeding. A constant phenomenon was the rapid formation of coagula in wounds in which free oozing occurred.

Bleeding Anticipated During Operation.—In some cases it was difficult or impossible to determine any effect from the citrate injection because of the necessary sponging at operation. In other instances in which sodium citrate was given the operative field was manifestly less bloody than could have been anticipated. Examples of anticipated post-operative oozing that did not occur after citrate injections are several operations on the lungs and bone operations for acute lesions in which oozing was still going on at the end of operation. The cases of jaundice comprise a special group. In the past two years there have been operations on twenty-five patients with jaundice of varying duration, due to common duct stone in the great majority of the cases, in which sodium citrate was given as the anæsthesia was begun. In not a single instance was there the dreaded excessive oozing at operation, although in many of the cases coagulation time and bleeding time had been pathologically prolonged. There were no post-operative hemorrhages. Oozing at later periods after operation occurred in a few cases, to be controlled by one or repeated doses of sodium citrate. There was not a single instance of a post-operative hæmatoma in the wound in the six months in which sodium citrate injections were used as a routine for all cases at the time of operation. At the present time we use sodium citrate in every case on our service in which there is any suspicion that oozing may be encountered at operation, and this prophylactic use of the drug has frequently proven of great value.

Summary

1. The administration of sodium citrate intramuscularly, intravenously, or subcutaneously, results in prompt and pronounced shortening of coagulation and bleeding time. This is a hitherto unrecognized pharmacological action of the drug.

2. The shortened coagulation time is of two to three hours' duration with gradual return to the normal within twenty-four to forty-eight hours.

3. The sodium citrate curve occurs not only in individuals with normal coagulation and bleeding time, but also in those in whom there is pathological prolongation, notably in jaundice.

4. It does not occur in blood diseases characterized by blood platelet deficiency—hæmophilia and purpura. These diseases appear to comprise the sole contraindication to the use of sodium citrate for the control of bleeding.

5. The dose for intramuscular administration of sodium citrate is nine grams for adults. A thirty per cent. solution is used, fifteen c.c. into each buttock, preceded by novocaine. The intramuscular method is free from danger, no untoward results having been noted in 200 cases, and is therefore the method of choice.

6. Internal as well as surgical bleeding, hemorrhage not only in normal individuals, but also in those with prolonged coagulation time are decisively controlled by sodium citrate injections in the great majority of cases. These are cases of oozing surfaces or hemorrhage from small vessels, for control of hemorrhage from large vessels cannot be expected with the dosage of the drug at present employed.

7. The method offers as well a large sphere of usefulness as a prophylactic measure against oozing at operation, especially in cases in which much bleeding is anticipated.

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FACTORS WHICH INFLUENCE LONGEVITY IN CANCER*

A STUDY OF 293 CASES

By William C. MacCarty, M.D.
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Practically every surgeon, clinician, and pathologist who follows post-operative results in cancer has occasionally been surprised to find that in some of his extensive cases patients live much longer post-operatively than others

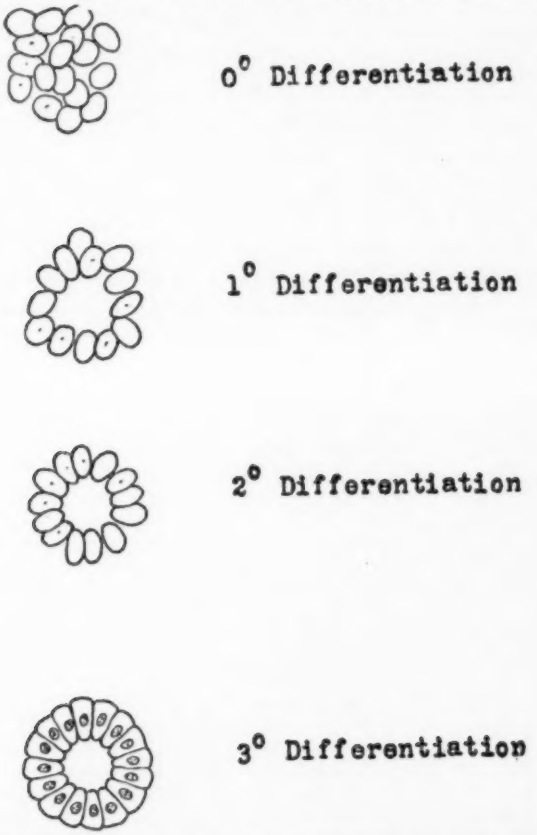


Fig. 4.—Degrees of cellular differentiation based on the stages of differentiation of specific tissues during embryologic development. In the stage without differentiation the cells are merely arranged in masses. In the first degree of differentiation the cells assume the general alignment of the adult tissue but without arrangement of the axes of the cells as in the adult tissue cells. In the second degree of differentiation the axes are parallel or form radii of a sphere or circles. In the third degree the cells assume the adult morphology of the units of the specific tissue.

with easily removable small growths. Such experience with cancer, after resection, led to the following investigation.

The material for study consisted of ninety-nine cancers of the stomach,[1] ninety-two cancers of the breast, and 102 cancers of the rectum. All the

* Presented before the Minnesota Pathological Society, November 15, 1921.

patients were known to have died of recurrence or metastasis after extensive radical removal of the growth. The specimens were studied to determine the frequency and possible influence of lymphocytic infiltration, fibrosis,

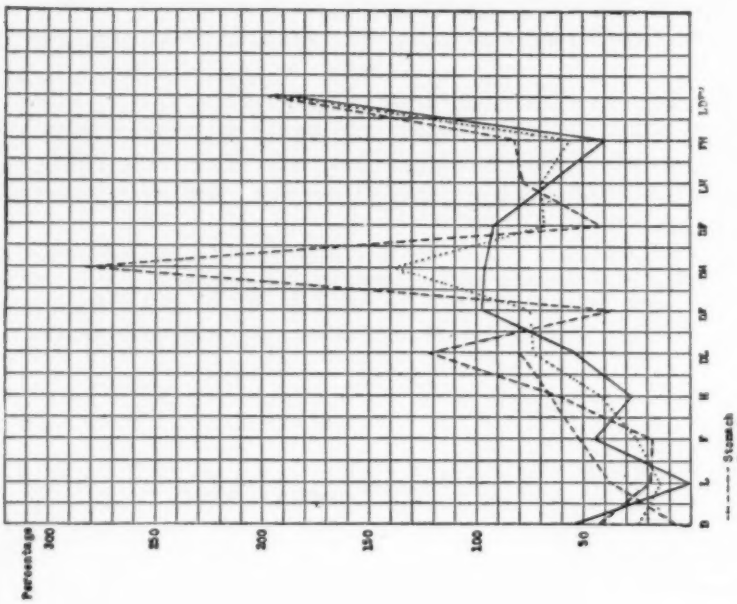
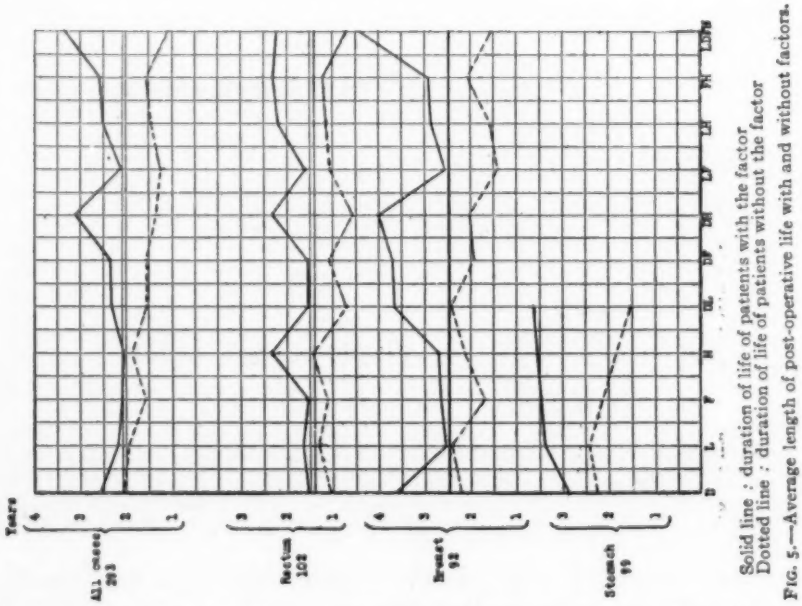


FIG. 6.—Percentage increase of post-operative life with factors checked against post-operative life without factors.



Solid line : duration of life of patients with the factor
Dotted line : duration of life of patients without the factor

FIG. 5.—Average length of post-operative life with and without factors.

hyalinization and cellular differentiation on post-operative longevity. Lymphocytic infiltration, fibrosis, and hyalinization were considered to be present only when they were found in intimate association with the cancer cells (Figs. 1, 2, and 3). By cellular differentiation is meant the structural changes which take place in the evolution of an adult tissue cell (Fig. 4).

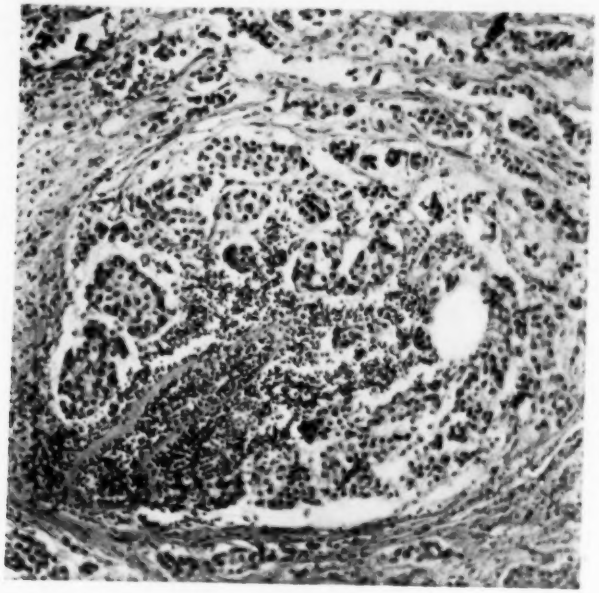


FIG. 1.—Lymphocytic infiltration intimately associated with cancer cells.

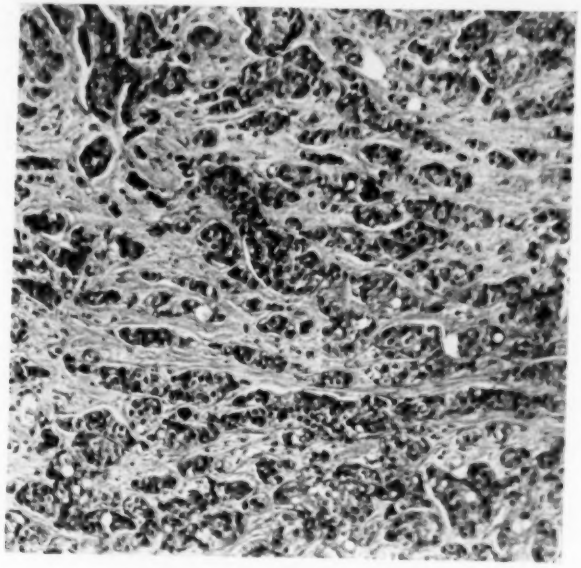


FIG. 2.—Fibrosis intimately associated with cancer cells.

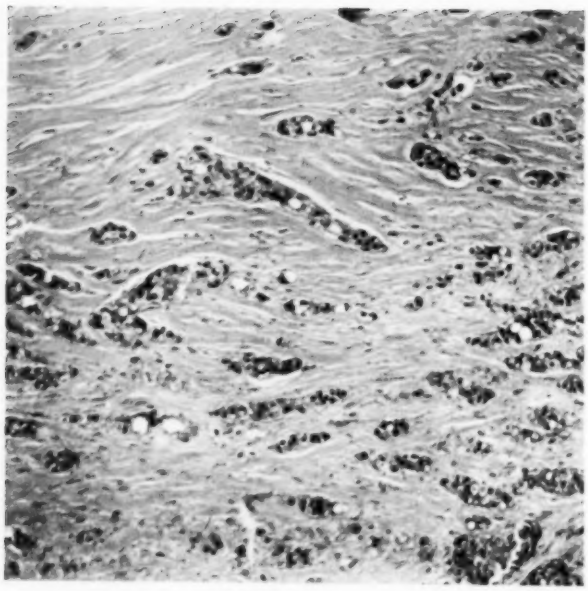


FIG. 3.—Hyalinization intimately associated with cancer cells.

An examination of the facts, charted in Figure 5, reveals that the average length of post-operative life is greater when the factors are present singly or in combination. When the facts are studied from the standpoint of percentage increase of post-operative length of life and checked against the average post-operative length of life without the presence of the factors, it may be seen (Fig. 6) that in the whole series there is a marked increase. If one charts the facts, from the standpoint of percentage increase in post-

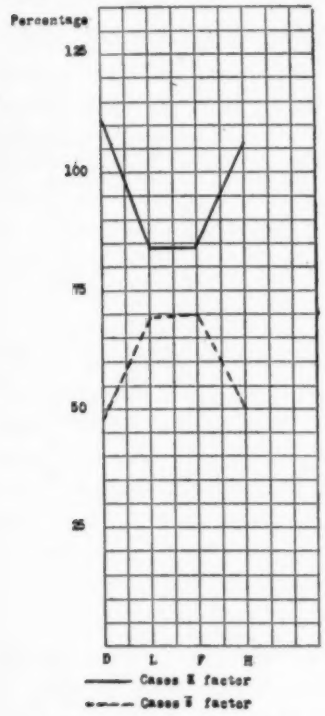


FIG. 7.—Average percentage increase of post-operative life in the presence of one factor (alone and in combination) checked against the absence of the factor.

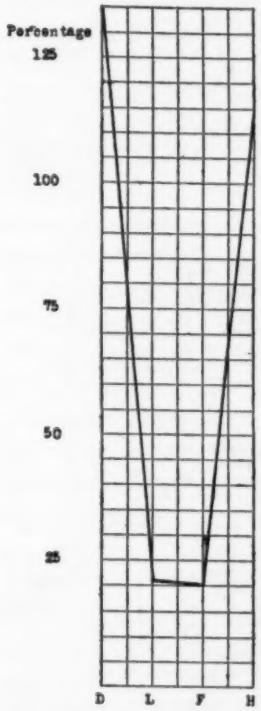


FIG. 8.—The percentage difference between the average length of post-operative life with and without the factors (alone and in combination) checked against their absence.

operative life in the presence of one factor (alone or in combination), checked against the absence of that factor, it may be seen (Fig. 7) that differentiation and hyalinization apparently play the greatest rôle in influencing the longevity. This is more striking if the percentage difference between the average length of post-operative life, with and without the factors (alone and in combination), is checked against their absence (Fig. 8).

In conclusion, it might be stated that the uniform consistency of increased length of post-operative life (in the presence of lymphocytic infiltration, fibrosis, hyalinization, and cellular differentiation) suggests that these factors play a significant rôle as a part of the natural defensive mechanism against cancer after it has once developed.

DATA OBSERVED IN THE SERIES OF 293 CASES.

	Stomach	Breast	Rectum	Total
Cases	99	92	102	293
Average length of postoperative life	2.62 years	2.5 years	1.47 years	2.19 years
Frequency of differentiation	65 per cent.	8.6 per cent.	86 per cent.	53.2 per cent.
Frequency of lymphocytic infiltration	91 per cent.	60 per cent.	57 per cent.	69 per cent.
Frequency of fibrosis	.....	68 per cent.	75 per cent.	71 per cent.
Frequency of hyalinization	.....	52 per cent.	2 per cent.	27 per cent.
Frequency of differentiation and lymphocytic infiltration	.....	6 per cent.	56 per cent.	31 per cent.
Frequency of differentiation and fibrosis	.....	7 per cent.	70 per cent.	38 per cent.
Frequency of differentiation and hyalinization	.....	4 per cent.	2 per cent.	3 per cent.
Frequency of lymphocytic infiltration and fibrosis	.....	40 per cent.	47 per cent.	43 per cent.
Frequency of lymphocytic infiltration and hyalinization	.....	27 per cent.	1 per cent.	14 per cent.
Frequency of fibrosis and hyalinization	.....	52 per cent.	2 per cent.	27 per cent.
	Years	Years	Years	Years
Average length of postoperative life with differentiation	2.73	3.65	1.54	2.64
Average length of postoperative life without differentiation	2.56	2.37	1.08	2.0
Average length of postoperative life with lymphocytic infiltration	2.73	2.51	1.57	2.6
Average length of postoperative life without lymphocytic infiltration	2.7	2.48	1.31	2.16
Average length of postoperative life with fibrosis	.....	2.72	1.53	2.12
Average length of postoperative life without fibrosis	.....	1.87	1.29	1.58
Average length of postoperative life with hyalinization	.....	2.81	2.33	2.57
Average length of postoperative life without hyalinization	.....	2.21	1.44	1.82
Average length of postoperative life with differentiation and lymphocytic infiltration	2.8	3.78	1.59	2.72
Average length of postoperative life without differentiation and lymphocytic infiltration	1.55	2.45	0.71	1.57
Average length of postoperative life with differentiation and fibrosis	.....	3.87	1.58	2.72
Average length of postoperative life without differentiation and fibrosis	.....	1.96	1.15	1.55
Average length of postoperative life with differentiation and hyalinization	.....	4.0	2.33	3.16
Average length of postoperative life without differentiation and hyalinization	.....	2.04	0.61	1.32
Average length of postoperative life with lymphocytic infiltration and fibrosis	.....	2.69	1.65	2.17
Average length of postoperative life without lymphocytic infiltration and fibrosis	.....	1.4	1.17	1.28
Average length of postoperative life with lymphocytic infiltration and hyalinization	.....	2.76	2.25	2.5
Average length of postoperative life without lymphocytic infiltration and hyalinization	.....	1.68	1.27	1.47
Average length of postoperative life with fibrosis and hyalinization	.....	2.89	2.33	2.61
Average length of postoperative life without fibrosis and hyalinization	.....	2.05	1.28	1.66
Average length of postoperative life with lymphocytic infiltration, differentiation, fibrosis and hyalinization	.....	4.4	2.25	3.32
Average length of postoperative life without lymphocytic infiltration, differentiation, fibrosis and hyalinization	.....	1.52	0.76	1.14

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THE FATAL OUTCOME OF CERTAIN CASES OF STAPHYLOCOCCUS INFECTIONS OF THE FACE AND LIPS*

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of New York, N. Y.

When I was studying medicine, thirty years ago, my attention was arrested by a statement in Treves' Applied Anatomy [1] regarding the facial vein. Mr. Treves called attention to the dangerous nature of infection of the face on account of the anastomosis of the superior ophthalmic vein with the facial at its origin at the root of the nose, so that a thrombophlebitis would readily travel along the facial vein through the ophthalmic to the cavernous sinus. I somehow got in my mind that the facial vein was a dangerous vein. Thereafter, whenever I resected or saw resected a superior maxilla and the incision started just over the angular vein and was carried down through the skin at the junction of the nose and cheek, I always had an uncomfortable feeling that this dangerous thrombosis might be started from the divided vein. It never did, however. As years passed I saw many infections of the face, some of them starting from infections about the hair follicles in the nostril. In these the lip was swollen; the nose was shiny and deep red; the eyelids were œdematous; but they all recovered after the discharge of a small amount of pus. Others were of the eyebrow and there were several of the chin. Finally I saw an extensive staphylococcus infection of the upper lip. The lip was hard, twice its usual size and dusky red. The cheeks and sides of the nose were swollen and hard; the eyelids were œdematous. The lip had been incised in several places. The surfaces of the incisions were covered with a grayish-yellow slough. The man recovered.

Shortly after, in 1911, a woman entered my service in St. Luke's Hospital with a similar condition. Forty-eight hours afterward she was dead. Since then, during the last twelve years, we have had in St. Luke's Hospital, including both services and in the private pavilion, seven patients with extensive infections of the lip. Of these six have died. I have seen one outside the hospital. He recovered. There was one case in 1915, one in 1916, one in 1918, two in 1920, one in 1921 and one in 1922. These were all extensive staphylococcus infections of the lip with multiple foci—examples of the condition we usually call carbuncles. One was of the lower lip and the others were of the upper lip. During the same period we have had eighty carbuncles of the neck, with five deaths. We have had a number of small furuncles of the face in patients going to the Out-patient Department and on the nursing staff. I have not included these.

I have thought it might be of interest to review these cases; to study the cause of death; to compare them with reports of similar cases published

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from time to time and to discuss the perplexing problems presented, especially as regards etiology and treatment.

The papers and case reports which have appeared are curiously similar and curiously dissimilar. The writer of the paper has usually seen one rapidly fatal infection of the lip. He has been shocked by the unexpected outcome. Strangely enough, the patient has very often been a young doctor or medical student. Within a comparatively short period he has seen other staphylococcus infections of the lip which have not died and he believes that the treatment of the furuncle in the first instance has been at fault. If the patient has died it is because the furuncle has been incised, or an exactly opposite conclusion has been reached and the opinion has been expressed that the incision has not been made early enough or wide enough. I will quote two examples: Lanz,[2] writing two years ago in Amsterdam, begins his article most dramatically as follows:

"Three of us were intern assistants in Kocher's Clinic in Bern. One of us was attacked by a furuncle on the upper lip and had this furuncle incised by an expert. Four days later he was dead. . . . Since that time I have no longer believed in incision in lip furuncles."

Doctor Powers[8] wrote in a paper published in February, 1901, twenty years earlier: "In 1886 a young physician attached to the Out-patient Department of the Chambers Street Hospital complained one day of a boil on his upper lip. Two days later we were greatly surprised and grieved to learn that he was dead." He concludes his article by advising early and wide excision of lip furuncles. Every year or two some such article appears.

Now we all know that superficial staphylococcus infections of the face and lips are very common; folliculitis barbæ in which the ordinary pyogenic staphylococci set up an inflammation, often purulent, in the hair-follicles of the beard are not uncommon, and pustular forms of common acne, solitary pimples and small boils are of everyday occurrence.

What is the interpretation of the particular gravity of infection by similar organisms in certain cases? Why have we five deaths only among eighty carbuncles of the back of the neck, many of these in the old, enfeebled, the diabetic and seven deaths in ten patients with carbuncles of the lip, all but one below forty-five years old? Why has death followed promptly after admission? In only one instance has death been delayed more than four days; four died within forty-eight hours.

The first thought on seeing these patients is that we are dealing with some unusual form of infection. Before 1880 a discussion of the subject invariably brought up the question of the type of infection. There were many discussions as to whether the patients were suffering from a malignant pustule or carbuncle. It must be remembered in reading these discussions that the word "anthrax" is used as it is in France to-day for carbuncle caused by staphylococcus. For instance, the cases reported in one of the early English papers on "Carbuncular Inflammation of the Lips and Other

Parts of the Face," by Mr. Harvey Ludlow (1852),[4] were said by Doctor Budd (1863) to be all characteristic examples of malignant pustules. Thomas Smith,[5] in *Holmes' Surgery* (1871), ventured to dissent entirely from this assertion. It has, however, now long been recognized that the infection is caused by the staphylococcus aureus. Repeated examinations and cultures have shown this organism usually in the pure culture.

Whether or not they represent examples of infection by unusual, virulent strains brings up very interesting questions. It is well known that within the same species of bacteria different strains may differ widely in virulence and that these differences may be readily artificially produced. They represent an adaptation of the bacteria to conditions met with in the medium in which they are grown. Increased virulence is related to conditions favorable for luxuriant growth. The astonishing rapidity with which microörganisms multiply is well known. Assuming that each one divides every half hour, then in twelve hours each will have more than fifteen million descendants. It would not be astonishing to find in the vast numbers present, even in a small infected area, after twenty-four or forty-eight hours, those that show especial adaptability to the conditions present and that grow luxuriantly. There seems to be no reason to believe that bacteria of unusual virulence are commonly found on the lips. I know of no instance of severe infection following operations for harelip, or following wedge-shaped excisions of the lip for new growths, or following resections of the superior maxilla. It is generally recognized that lacerated and even contaminated wounds of the face and lip heal most satisfactorily.

For fifty or sixty years the fact that thrombosis of the cavernous sinus may follow infections of the lip has been mentioned in text-books of surgery. The protrusion of the eyeball, the œdema of the lids, the swelling and eversion of the conjunctiva are obvious signs of the condition. Such was the clinical picture in Case II of our series. Furthermore, at autopsy, not only have purulent thrombi been found in the sinus, but the suppurative phlebitis of the ophthalmic vein, on one or both sides, has often been recognized. These were the autopsy findings in Case VII of our series. But in the third case reported, death followed infection of the lower lip and there was a red, indurated, brawny swelling extending in the neck, not up toward the eye; and in the autopsy findings in Case VIII, although the infection was of the upper lip and there was moderate œdema of both eyelids, the autopsy findings showed no lesion of the brain, meninges, ophthalmic vein or cellular tissue of the orbit. The patient died of staphylococcus sepsis with multiple septic infarcts of the lung. The day before death the blood culture was positive for staphylococcus aureus.

In 1869, Reverdin[6] made an autopsy on a woman who had died following a carbuncle of the lower lip. Both lungs presented numerous metastatic abscesses. The meninges, sinus and brain were normal. As the body was not claimed, two days later he made a dissection of the face. The internal jugular vein was

healthy; a recent clot occupied the part of the vein adjacent to the angle of the jaw. The external jugular was filled in its cervical portion with a fibrinous clot mixed with liquid blood. Its facial portion and the tributary branches were obstructed and filled with broken-down blood clot, forming a reddish-gray, grumous material. The angular vein was completely obliterated in all its extent up to the angle of the eye; one of the labial veins was obliterated, as well as several of the muscular branches. Finally, a large branch, which passes over the jaw to empty into the internal jugular, was filled with a broken-down blood clot which ended in a point within the lumen of the internal jugular. He summarized his observations thus:

"Phlebitis of the facial vein, starting at the level of the commissure of the lips, extending, on the one hand, upward to the inner canthus of the eye but stopping there, on the other, by the transverse vein of the face to the external jugular and from there by an anastomosing branch to the internal jugular." An infected clot was projecting into the jugular; a portion of it had evidently broken off and been swept away by the blood stream.

Unfortunately, it has not often been possible to dissect out the thrombosed veins of the face, but at the time Reverdin wrote there had been ten similar observations. In each instance a purulent phlebitis had been traced from the focus of infection. This thrombophlebitis extends from the focus of infection often upward along the angular to the ophthalmic vein, but not uncommonly downward to the jugular. Obviously, such an infectious phlebitis can cause death in two ways: either by involvement of the cavernous sinus and the concomitant intracranial lesions or by a portion of the clot containing multitudinous organisms breaking off and being carried away by the venous circulation to the right heart and hence to the lungs.

Lenhartz,[7] in his book on Septic Diseases, gives the autopsy findings in eight cases of staphylococcus sepsis following furuncles on the lip, nose or eyelid. He calls attention to the striking tendency for an infective thrombophlebitis of the facial vein to follow infections of the upper lip.

Lenhartz quotes his second case to show that death may occur from sepsis and yet no suppurative thrombophlebitis be recognized at autopsy. The patient, a girl twelve years old, had had a furuncle of the upper lip. When she entered the hospital, two days later, the lip and left cheek were much swollen and several cords could be felt in the cheek. Both jugulars were ligated and the œdematous swelling incised. The entire upper lip was studded with small purulent foci. She died the next day. The lungs and kidneys showed septic infarcts. There was no evidence of thrombophlebitis in any of the veins or the ophthalmic. There is no record, however, of a careful dissection of the small veins of the face. In two of his autopsies there was a massive phlegmon of the face, diffuse purulent meningitis and infarcts of the lung. He gives these as examples of the spread of infection through the orbit to the meninges by direct progression through the lymphatics and cellular tissue.

We all know that the staphylococcus blood-stream infection occurs from cocci entering the blood from small foci of infection. Every hæmatogenous osteomyelitis is an example. But in these there is no massive blood infection,

with evidence of infarcts in the lungs, in question. The rarity of such a condition following furuncles or carbuncles situated elsewhere furnishes a striking contrast to the frequency of suppurative thrombophlebitis following furuncles of the lip. It is in this that the danger of the lesion lies. A malignant furuncle or carbuncle of the lip is a furuncle or carbuncle accompanied by a suppurative thrombophlebitis, and the danger of the condition lies in the tendency for infection, situated in the lips and nose, to involve the labial venous plexus.

The skin of the lip is very adherent to the underlying muscles, the fibres of which are inserted into the derma. There is little or no loose connective tissue and fat beneath the skin; the main substance of the lip is made up of a network of muscle and connective tissue. The muscles in general are arranged in two sets: first, a group of curving fibres forming a true sphincter about the oral orifice (the orbicularis oris), and second, a group rising from various parts of the face and converging toward the oral orifice and interlacing with the orbicularis. These muscle fibres are imbedded in a dense connective tissue making up the substance of the lip. There is a rich venous plexus which cuts obliquely the direction of the orbicularis oris, one portion of the venous network being superficial, one being beneath the muscle. The collecting venous trunk for the upper lip ascends along the nasolabial groove to empty into the facial at a point at the level of the nostril or even at the lower border of the orbit. There are usually two rather slender collecting branches for the lower lip. They ascend obliquely and the lower empties into the facial low down in the submaxillary portion. There are no valves in the facial vein; at least, the vein can be readily injected from the jugular; but the labial veins have numerous valves so that it is difficult to force injection into them from the facial.[8]

When a furuncle or small staphylococcus infection passes beyond the skin or mucous membrane of the lip and penetrates the substances of the lip, it can only spread in the complicated framework of dense connective tissue between the various muscle bundles and in close contact with a rich plexus of veins. Thus it is not surprising that a suppurative thrombophlebitis is readily established. When this thrombophlebitis becomes progressive and spreads to the collecting veins two additional factors, I believe, almost always come into play—motion and trauma.

The first principle of treatment for phlebitis is rest. At the onset of infection of the veins, before the lips have become greatly distended, every contraction of the various muscles entering into the complex musculature of the mouth must press and squeeze the thrombosed, infected veins.

Rosenbach[9] suggests (a rather fanciful view) that the anatomical relation of the muscles of the skin and the cellular tissue is such that infectious material is forced and "pumped" into the neighboring connective-tissue framework.

The second factor is trauma. A small pimple has been squeezed or

pressed; a needle or pin has been thrust into the inflamed area. The disfigurement of the trifling infection seems of great moment and, in front of a glass, with various grimaces, the infection is attacked. If it does not subside medical aid is sought; the small furuncle is pricked or stabbed or a pointed orangewood stick covered with carbolic is thrust into the supposed centre. The doctor is spurred on by the requests of the patient to be immediately relieved of the unsightly lump. Furuncles that would be carefully preserved from injury in other parts of the body less open to inspection are, in this situation, subject to repeated insult. This is not a fanciful picture.

Case history after case history shows the same story: a small furuncle with redness and swelling, usually of only one or two days' duration, is pricked or squeezed. It usually becomes worse; a physician is called. He makes a small wound or thrusts a blunt instrument into it. The place of puncture is not determined by a visible focus. After each incision the patient grows worse.

If a small puncture is made through the derma into the firm connective and muscular tissues of the lip, it is almost certain to sever or nick one of the smaller veins. The blood escapes only partially externally; a portion spreads out along the lines of least resistance within the tissues. This is all the more marked if the small wound is tightly packed. Now stagnant blood within the tissues, in an infected area, furnishes an excellent culture medium for bacteria. Dorst [10] has found it increases about forty-fold the potency of staphylococci.

About every focus of infection a wall of leucocytes is rapidly formed. On the integrity of this wall depends whether or not the microörganisms advance into the tissues. This wall is at first very delicate; as time passes it becomes better and better established. The experiments of Giani [11] are interesting in this connection. He soaked filter paper in a virulent culture of anthrax bacilli, then laid the piece of paper as gently as he could on the surface of fresh wounds two, six, eight, ten and fourteen hours after the division of the tissues. If, by the slightest roughness, the protecting wall of leucocytes which had already formed at the end of two hours, was broken (he recognizes this by slight signs of hemorrhage) the animal died. Even at two hours a third of the animals survived. At the end of fourteen hours the wall was strong enough to resist these gentle manipulations and all recovered.

Punctures and rough manipulations may, time after time, break through this protecting cellular wall. Hardly has the protecting wall again formed when it is again broken through until finally a widespread and dangerous infection is established. In Case VI, for example, the small pimple was pricked, then squeezed and twice incised within the first twenty-four hours.

As we have said, the papers on this subject come to very different conclusions regarding treatment. If we examine the reported cases, some foundation may be found for these varying conclusions. Obviously, results

of treatment can only be judged when all the lesions are taken into consideration. Is the case reported a simple furuncle of the lip; is this complicated with phlebitis; is the phlebitis progressive; is there massive infection of the blood-stream from portions of broken-down thrombus; have bacteria only entered the circulation from the focus? These are questions that must be asked in every instance.

In Case VIII, for example, blood culture made the day of admission was positive for staphylococcus aureus, and at autopsy, two days later, there were multiple septic infarcts of the lung. It would be unwise to draw conclusions as to the efficacy of any form of local treatment to the lip carried out after this patient entered the hospital.

Reverdin (*loc. cit.*) was convinced from the following case that early and wide incision should be done: A woman, twenty-two years old, ordinarily in good health, had a hard, infected area about the size of a nut on the lower lip near the commissure. It was yellowish red on the summit and the neighboring portions of the lip were swollen and hard. She had had the infection two days. Reverdin made a deep, crucial incision. She grew worse during the night. The next day the whole lip was greatly swollen and hard and the temperature was 104. She was taken to the hospital and a wide incision was made through the infected area; only a few drops of pus escaped from the wound. Numerous small, yellowish foci were seen scattered through the incised area. Two days later a hard cord could be felt beginning above the clavicle and extending along the medial border of the sternomastoid; it became indistinct above, being merged into the submaxillary swelling. Three days later the fourth operation was done—opening a collection of pus under the chin. She recovered. She was seen early when there was no widespread infection; the infection spread after every operation; she was desperately ill and developed a suppurative phlebitis. Did the frequent incisions favorably or unfavorably influence the spread of infection?

Rosenbach (*loc. cit.*) also believed in wide and early incisions. I report his first case: The patient was a sixteen-year-old boy, who came under his care five days after the onset of his infection. The whole upper lip and left side of the cheek were swollen and hard; on each side an indurated cord extended upward from the furuncle. Under general anæsthesia the entire focus in the upper lip was opened, one incision passing vertically through the lip, the other transversely. Incisions were made as well through the most indurated portions of the swellings on the chin and cheek. The following day two more incisions were made as the infiltration was progressing on the chin. Two days later the necrotic tissue began to loosen, but, as the left cheek was infiltrated, red and painful, this tissue was incised. A few days later the infiltration had spread to the parotid region and neck. Shortly after, the right ankle became inflamed and was subsequently incised. Four months afterward the scars on his face had healed and the patient had a stiff ankle-joint and a discharging sinus. The infection advanced after each operation. The patient finally had a blood-stream infection with a metastasis.

In the first case reported by Powers (*loc. cit.*) the carbuncle was of moderate size. The cheek was swollen alongside the nose to the margin of the orbit. The indurated area was freely incised and the necrotic mass excised. His second and third cases were similar. They all recovered satisfactorily. He tells of a disfiguring scar in the first. In none of his cases was there evidence of a thrombophlebitis.

On the other hand, Walters, Coombe and Solly[12] reported in 1909 a very

extensive, indurated, staphylococcus infection starting close to the commissure of the lip, with œdema of the lid, brawny induration of the entire cheek spreading to the submaxillary and parotid region. The child was treated with vaccines and the administration of repeated doses of citric acid and recovered. I refer to this case, not to call attention to the efficacy of vaccines or citrates, but to show recovery without incision.

In 1910, Keppler [13] reported twelve cases of facial infection treated successfully by Bier's constriction method. Only four of these, however, seemed severe. Here again I refer to the cases not on account of the treatment by hyperæmia, but to show that they recovered without early or wide incision or excision. He applied his constriction, simply lifted gently the head of the pustules, waited for the cores to loosen and removed them.

A few months later Wrede,[14] from Lexer's Clinic, reported eight cases of lip furuncles, without a complicating suppurative phlebitis, which he had treated conservatively, that is, without incision. He criticised justly Keppler's treatments on the ground that the artificial hyperæmia obscured the clinical picture, prevented satisfactory inspection of the progress of the infection and the detection of complicating suppurative phlebitis. Lexer,[15] even, reports a case of fatal sepsis following a single treatment of a small lip furuncle by suction. Both Lexer and Wrede advised wide incision through the indurated areas when a progressive, suppurative phlebitis is present.

Lenhartz (*loc. cit.*), in his most interesting book on Septic Diseases, says that he is opposed to early incisions of lip furuncles. He had had the opportunity of watching on two services of the Eppendorfer Hospital the two plans of treatment. While he has seen many recoveries following wide and early incision, he has also seen many disasters. This testimony is interesting as coming from a medical man, especially interested in the autopsy findings in sepsis.

My own views are that although furuncles and pimples of the lips and face are very common and usually subside, even when they are squeezed, pressed, pricked and punctured, these are dangerous measures to apply to any infection and are especially dangerous in the lip. The knowledge should be widespread that every furuncle of the face and nose, and especially of the lip, should be treated as if it might become a dangerous disease. It should be more generally recognized that danger lies in a complicating suppurative thrombophlebitis, and that mechanical injury, the arrangement of the labial plexus of veins and the inevitable movements of the parts are factors of great consequence in spreading infection.

I believe that early operations and rough manipulations in the infected area tend to spread, not to limit, the infection. The small infection should be kept at rest, the skin about it gently cleansed and covered with some simple ointment. The focus of infection should not be rubbed or squeezed or pricked or handled. It is dangerous to try to abort furuncles by puncture through the white or red point with a toothpick or wooden applicator dipped in phenol, nor should phenol be injected in the indurated tissue.[16, 17] Early puncture before there is a definite focus of suppuration and then tightly packing the small hole to arrest bleeding is admirably suited to create con-

ditions in the dense tissue of the lip favorable for rapid bacterial growth and the spread of infection to the labial veins.

Considerable induration about the focus of infection and œdema of the loose cellular tissue of the eyelids is not uncommon in moderate infections and is not a sign of ophthalmic phlebitis.

Local anæsthesia should never be used; the infiltration still further increases the tension and may force infectious material deeper into the tissue. Incision with a sharp knife is indicated if there is a local abscess or if the parts have become enormously swollen and livid or for intolerable pain. If it is necessary to incise widely in infections of the upper lip with extension along the angular vein, the incision should follow the line of incision for resection of the superior maxilla.[18] When and how much to incise must depend finally on the judgment and experience of the individual surgeon. Sharp severance of the tissues relieves tension. It can do no harm unless it is accompanied, as it so often is, by pressing, squeezing or pushing blunt instruments into the severed tissue searching for collections of pus. Usually there is no free pus; there are scattered purulent foci and a hard, necrotic core. Unfortunately, it is generally necessary to stuff the wound with gauze to stay the copious hemorrhage. This gauze rapidly becomes adherent to the wound surface and soon checks any outflow from the wound. Furthermore, the removal of the adherent gauze is apt to cause bleeding and injury to the newly formed granulations.

The fatal cases we have reported were all examples of widespread, general infection or cavernous sinus thrombosis complicating an infection of the face when they came under observation. No local treatment of the original focus could avail; all were widely incised under general anæsthesia. We considered, but rejected, the idea of opening the cavernous sinus in two of the patients in whom the infection had already reached that point. The cavernous sinus has been incised a number of times. A paper was published in 1902 on the subject and a case reported by Dwight and Germain.[19] Tavernier [20] some years later also reported a case. One patient lived a few hours and the other ten minutes or more after the operation. Not only is the sinus difficult to approach but conditions in the sinus are not at all like those in the lateral sinus. The lumen is divided up by a network of round and flat trabeculæ and an infected clot caught in the meshes of the sinus network cannot be removed by a curette. Large veins also enter at a number of points along which infection can readily travel. The idea that thrusting a knife into the sinus might influence favorably the spread of infection seems to me to show singular ignorance of the morbid anatomy.

Both the jugular vein and the facial have been ligated with the idea of preventing the spread of infection. Lexer (*loc. cit.*) reported a case of carbuncle of the cheek in which there was a purulent thrombophlebitis of the facial and general infection and in which he was able to avoid further metastases and cure the patient by ligation of the jugular. Ligation of the

jugular should be considered in cases where there is a blood-stream infection and signs of general sepsis. It might have been considered in Case VIII of our series. The autopsy findings showed, however, a lesion of the lungs sufficiently advanced to make it very improbable that ligation would have controlled the spread of the infection. In other words, when the patient entered the hospital massive infection of the blood-stream had already occurred.

Tavernier (*loc. cit.*) mentions the ligation of the jugular vein by Texier, but the plexus of veins and numerous anastomoses, the massive infiltration of the surrounding cellular tissue, all make it difficult to recognize the thrombosed veins. Obviously, ligation should only be done on a sound vein wall at an appreciable distance from the infected thrombus. The distance between the entrance of one of the labial or nasal veins to the point where the ophthalmic vein enters the angular is very short, often hardly an inch. It seems to me that there would be a real danger of disturbing and loosening a thrombus in the endeavor to ligate at this point. In none of our cases, I believe, would ligation of the angular at the time they came under observation have prevented the involvement of the cavernous sinus.

My attention has been directed by these fatal cases, in which the failure of any form of treatment was to be expected, to the endeavor to determine the conditions which change a simple circumscribed staphylococcus infection into a widespread and dangerous lesion, and I cannot escape the conclusion that many such simple lesions are often so changed by ill-advised treatment at the onset of the infection.

Reading over many of the case reports recalls to my mind the treatment advised by Dr. San Grado in Le Sage's romance of "Gil Blas." Dr. San Grado believed in bleeding and in the ingestion of large quantities of water. When his patients died he believed he had not bled them enough or caused them to drink enough water. These conclusions applied logically during a long lifetime lead to an astonishing mortality.

RECORD OF CASES

CASE I.—F. S., age forty-four. Admitted July 17, 1911. Died July 19, 1911. Diagnosis: Carbuncle of upper lip, cellulitis of face, septicæmia. Operation: Multiple incisions.

Patient had a boil on upper lip which gradually began to swell, became very red and painful. Her physician had incised it twice in two days, but her condition continued to grow worse.

Upper lip enormously swollen and indurated and dusky red. Side of nose and adjacent parts of face much swollen; lids œdematous.

Under general anæsthesia multiple incisions were made through inflamed tissue. No free pus found. Firm grayish-red surface on cut surfaces.

Temperature: On admission 105, 104.3, 105.2; second day, 104.3, 104.1, 104.4, 104.3; third day, 106.4 (died).

CASE II.—L. G., age thirty-four. Admitted May 22, 1915. Died June 20, 1915. Diagnosis: Cellulitis of face, cavernous sinus thrombosis, staphylococcus septicæmia. Operation: Multiple incisions in lip and incisions in orbital cellular tissue.

Small infection inside nostril was pricked, then incised and squeezed. Swelling and induration extended to lip, then along naso-facial groove. Both lids became œdematous, conjunctiva much swollen and red, protruding between eyelids; cellular tissue of orbit obviously infiltrated.

Multiple incisions made under general anæsthesia; small amount of free pus evacuated. May 22nd to June 1st temperature varied from 101 to 104. June 2nd, blood culture showed staphylococcus aureus. June 3rd, low delirium. June 14th, temperature 100; less irrational. June 19th, temperature had been normal for several days; condition of eyes unaltered. June 20th, grew rapidly worse, pulse became rapid and feeble.

Case III.—S. R., age forty-one. Admitted November 20, 1916. Died November 25, 1916. Diagnosis: Carbuncle of lower lip. Operation: Multiple incisions.

Present illness started six days ago as a small pimple just below the lip, a little to the right of the median line. Patient picked off the scab and twelve hours later the lower lip began to swell and became red and painful. Family doctor gave her an ointment which did no good; lip became larger and more painful and hot. Patient was unable to talk, eat or sleep. Twenty-four hours ago lip was incised.

General appearance is that of a well-developed and well-nourished woman who seems acutely ill. Pupils react normally; ears and nose negative. Many teeth missing; the rest are discolored, decayed and show extensive pyorrhœa at the roots. Tongue is dry and coated. Lower lip greatly swollen, much thickened and protrudes enormously. Whole lip is a bluish-red color, hot and indurated, and on upper surface shows several pin-point holes oozing pus. Extending down to the thyroid cartilage and equally distant on both sides is a general red, indurated area. Submaxillary glands are enlarged. Physical examination otherwise negative.

Under general anæsthesia wide incisions were made through indurated tissue.

Temperature on admission was 104; second day after operation 105, 106.2; third day 106.2, 107, 107.3, 108.2, 109.2 (died).

Case IV.—O. McC., age sixty-five. Admitted January 12, 1918. Died January 14, 1918. Diagnosis: Cellulitis of face. Operation: Multiple incisions.

Present illness started four days ago as a pimple on left side of septum. Was treated by physician who pressed out core of abscess, and later swelling of face and present condition resulted. Yesterday temperature was 105. Has had wet dressings on face. Past history negative. There is a slight swelling and redness about both eyes. About mouth, nares and over entire right cheek, as far back as ear and right side of neck, there is a swelling with redness and brawny induration. Upper lip shows several pustules from which pus can be pressed. Especially tender at right side of neck. Examination otherwise negative.

Operation was performed under general anæsthesia. Two linear incisions two inches in length were made in the upper lip and with blunt dissection the surrounding tissue was opened and the incisions were packed. Wet dressing applied.

Temperature on admission 104.5, 104, 105, 104.1, 103.3, 105, 105.1 (died).

Case V.—A. K., age forty-two. Admitted December 11, 1920. Discharged (cured) December 12, 1920. Diagnosis: Infection of face. Operation: Multiple incisions.

Present illness began four days ago. Patient noticed a small pimple near upper lip. He squeezed it but it gradually got worse, became more swollen and painful. He applied lysol which gave him some relief, but he has been unable to sleep with the pain.

He is a well-developed and well-nourished adult, subacutely ill. There is a diffuse swelling of the upper lip and lateral aspect of the nose. At a point just about

opposite the ala nasi there is evidence of pus about a furuncle which had been scratched by the patient.

Under general anæsthesia an incision one and one-fourth inches in length was made vertically over the most necrotic area; the pus was expressed from the wound. Hot wet boric dressings were applied.

Temperature 101.1, 99.2.

Case VI.—G. S., age forty-two. Admitted October 28, 1920. Died October 29, 1920. Diagnosis: Furuncle in nose, cellulitis of face, cavernous sinus thrombosis. Operation: Multiple incisions.

Four days before admission patient noticed small pimple just under the nose that seemed to have some pus in it. He opened it with a needle that he had previously run through a flame and squeezed out a small amount of pus. The infection seemed to spread and the next day it was lanced. General signs continued and it was opened again the following day. The day before admission drainage was enlarged, but infection seemed to have increased.

Patient is a well-nourished and well-developed man, acutely ill. There is a marked swelling and œdema of upper lip and nose. On the inside of the right nostril is a spot which appears to be a slough. There is a very intense œdema throughout all the tissues in the face. Physical examination is otherwise negative.

General anæsthesia was used and incision made through the mucous membrane beneath the upper lip, parallel to the teeth line and communicating with the nose. Several punctures were made in the upper lip and the wound packed with iodoform gauze. Wet boric acid pads applied as dressing.

Temperature 102.4, 104.2, 102.3, 103, 105 (died).

Case VII.—C. K., age twenty-nine. Admitted October 6, 1921. Died October 10, 1921. Diagnosis: Cellulitis of upper lip with cavernous sinus thrombosis. Operation: Multiple incisions.

Present illness began four days ago. Patient picked a boil that was just inside the right nostril. His nose became very sore and about six hours later his sister noticed that his upper lip was swelling. This swelling increased rapidly, passed up the right side of the face until his eye was swollen and closed. He was unable to sleep after swelling began. Previous health had been excellent; had had no serious illnesses, operations or injuries.

Patient is a well-developed and well-nourished man, acutely ill. Upper lip and right side of face markedly swollen and œdematous. On the upper lip, just below the nasal septum, there is a small indurated swelling with a necrotic centre. The lip and right side of the face and tissues around eye are swollen, red and painful. No area of definite fluctuation. The right eye is closed by œdema. Pupils react promptly to light. No derangement of any of the eye movements.

Under general anæsthesia an incision was made in the upper lip, extending from the nasal septum to the vermilion line of the lip and artery clamps were inserted into the deeper tissues in a search for the pocket of pus; no frank pus was found. Rubber dam drain was placed in the wound. Dry sterile dressing applied.

On October 8th a second incision was made over the right temporal region, lateral to the eye, and another curved incision below the right eye. No frank pus was seen. The incisions were packed with plain gauze. Wet dressings applied.

Pathological Findings: The tissues surrounding the right eye were markedly œdematous and the conjunctiva had begun to protrude from the edges of the eyes. There was a slight protrusion of the left eye also. No definite areas of fluctuation could be made out.

FIG. 1.—Condition presented by Case VII, after death. Cellulitis of upper lip, with cavernous sinus thrombosis.

Temperature, on admission, 102.4, 104, 103; second day 103, 103.4, 101.3; third day 102.3, 103, 103.2; fourth day 103.3, 104.4, 104 (died).

Autopsy (performed October 10, 1921): The body is that of a large, well-developed white man, aged about thirty years. Rigor mortis slight. Body slightly warm. Marked œdema of face, most extreme of lower lip and orbital regions. Slight exophthalmos of both eyes, more marked on left. Chemosis both conjunctivæ; marked congestion of face, more on right, with purulent dermatitis and probably thrombosed vessels of right supra-orbital and temporal regions, as there are hard, dark purplish nodules in the skin. There are three surgical incisions in the fascia of the face, one oblique one on the upper lip near the middle and two below the eye on the right side. All are unhealed, show indolent, infected edges, but are not actively suppurating.

The right lung is loosely adherent throughout by fresh fibrinous exudate, especially the outer surface of the lower lobe, where there is a large ragged mass of it. On section both lobes are largely filled with large and small infarcts due to septic emboli. Some of these are suppurating, showing small abscess cavities in the centre. The right lung weighs 700 gm. The left lung weighs 650 gm. It shows approximately the same picture as the right, the nodules varying in size from one to three cm. in diameter, all either suppurating or composed of fresh blood clot in the tissues.

On incising the galea and temporal muscle on the right, the muscle is found to contain many miliary abscesses and some hemorrhage. The muscle is also very œdematous and considerably thickened from excess of fluid.

The longitudinal sinus contains a post-mortem clot which is free, leaving the dura smooth and shining. In the anterior fossæ, however, the dura is considerably injected and shows small hemorrhages around the body of the sphenoid bone on both sides of the clinoid processes. The cavernous sinus is thrombosed throughout, being filled with a pale yellowish pink, soft clot which adheres tightly to the walls and extends downward into the basilar plexus and probably the inferior petrosal sinuses. The longitudinal and transverse sinuses are entirely clear, containing post-mortem clots only. The bone itself is not softened; is firm and white when the dura is stripped from it.

The dural vessels are not otherwise noticeably injected. The ethmoid and sphenoid sinuses are lined with pale yellow mucosa, with no evidence of infection or hemorrhage. The pia is considerably injected, but there is no hemorrhage and no evidence of suppuration. Sections of the brain show no lesions. The ventricles are not distended. The choroid plexuses are normal. The pituitary is firm; the stalk much injected.

The fascia posterior to the eyeball shows a few small hemorrhages. Dissection shows the superior ophthalmic veins firm and much injected, thrombosed on both sides, but more conspicuously so on the left.

Case VIII.—G. W., age sixteen. Admitted January 8, 1922. Died January 10, 1922. Diagnosis: Carbuncle of upper lip; general septicæmia. Operation: Multiple incisions.

Two days ago patient picked small pimple on upper lip. Lip soon began to be red and painful and swelled rapidly and has gradually extended to its present dimensions. Has had high fever and general malaise and one chill this afternoon. Has never been sick before. Face is red, hot and swollen; both eyes are closed on account of the swelling. The upper lip is very red and swollen, showing several small abrasions said to be the original focus. The œdema is brawny over the upper lip.

Multiple incisions were made under general anæsthesia. Temperature on admission 104.2; at time of death 108.2.

Autopsy (performed January 10, 1922): The body is that of a boy aged sixteen. General development and nutrition good. Body cold. Rigor mortis present. Three small incisions five-tenths cm. in upper lid from which purulent exudate and neurotic tissue can be expressed on slight pressure. The tissues of the face are œdematous and the upper lip markedly swollen. The lids of the left eye are slightly swollen. There are no other bruises or marks of external violence.

On opening the abdomen there is no free fluid or other exudate on the right side, but the anterior surface of the stomach, where it is overlapped by the liver, is slightly discolored by brown coffee-ground material. In the left upper quadrant covering the fundus of the stomach and surrounding the spleen is a considerable quantity of semi-fluid, black, sticky material which is evidently stomach contents as a large defect in the anterior wall of the stomach just below the cardia is present. The edges are very soft and break down further readily on pressure. The dissolution of tissue extends into and involves the lower right corner of the left pleural sac and about 500 c.c. of the same fluid are present in the left pleura. The surrounding portions of œsophageal and cardiac wall are not congested, are pale, soft, and show a few prominent vessels, probably thrombosed. The pericardial sac contains the normal amount of clear fluid; the surface is smooth, the left ventricle contracted and the valves show no lesions. The left lung is coated with flakes of fibrin; is studded throughout with many hard hemorrhage nodules, probably infarcts. The intervening tissue is in many areas firm, vascular and granular, due to areas of broncho-pneumonia. The right lung is still more involved, contains a large hemorrhage at the right apex and shows considerable purulent exudate in and around the bronchi of the lower lobe. The surface is also coated with fibrin.

The liver is soft, flabby and much congested. The gall-bladder is normal. The spleen weighs 140 gms., is soft, wrinkled, purplish red, and shows on section loss of markings and much swelling of the tissues.

The kidneys are of normal size; the capsules strip readily. They show acute congestion, but well-preserved markings. The ureter and bladder are normal.

Section of the galea aponeurotica shows marked œdema of the right temporal muscle with some hemorrhage. The dura is intact; the sinuses are not thrombosed. The pituitary shows normal relations and size. The cord is free; the pia arachnoid is free and there is no excess of fluid. There are no gross lesions of the brain demonstrable on section. The ophthalmic veins are not thrombosed.

Anatomical Diagnosis: Carbuncle of upper lip; septicæmia; septic infarction of lungs; acute fibrinous pleurisy; broncho-pneumonia; necrosis of cardiac portion of stomach and left pleura; parenchymatous degeneration of viscera.

Blood culture, January 8, 1922, was positive for staphylococcus aureus hæmolyticus.

NOTE.—The histories of two patients with carbuncles of the lips and staphylococci in the blood stream have not been given.

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HÆMANGIOMAS OF THE GASTRO-INTESTINAL TRACT

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Rokitansky asserts that although hæmangiomas are capable of developing after birth they are generally congenital and rarely occur later in life. He holds that many angiomas represent simple hypertrophy of the vascular segments without neoplastic overgrowth. Virchow teaches that the blood-vessels in angiomas develop from sprouts which appear first in the site of preëxisting blood-vessels. He considers the hæmangioma a proliferating tumor, its growth being due to an active irritation which causes the tissues to granulate and results in a rich mass of connective tissue. Trauma at times can be demonstrated as a factor. Thoma refers much of the growth of hæmangiomas to mechanical factors, an increase in blood-pressure and loss of support to vessel walls from changes in the surrounding tissues; this tends to excite a new growth of vessels, while an increased rapidity of flow favors elongation and dilation of the walls.

Hæmangiomas are essentially endothelial tumors composed of capillaries or cavities, or of any gradation between the two. They may be either highly vascular or composed almost entirely of endothelial elements. The capillary type is by far the most important clinically. The vessels and cavities of both types are lined by endothelial cells, usually only a single layer. The walls of the larger vessels are sometimes several cells in thickness. In some hæmangiomas, especially in long-standing processes, there may be comparatively few vessels. Capillaries may have been obliterated and replaced by masses of endothelial cells which have continued to proliferate. This results in characteristic endothelial whorls which are not infrequently accompanied by an overgrowth of fibroblasts. In the majority of cases, the hæmangioma remains local. Complications result from the local condition and are dangerous to the patient insofar as they encroach on vital structures or, by erosion of their limiting walls, cause hemorrhage. At times the growth becomes very extensive. A girl (Case A14928), aged nineteen years, was entirely incapacitated by a tremendous angioma of the urinary bladder; an extension, twelve centimetres in diameter, reached outside the wall of the bladder into the pelvis. The mass was resected and seven years later the patient was entirely well. In a similarly located angioma in a girl of seven (Case A18434), the patient was in no serious danger until the tumor eroded through the rectal wall, shortly after which a hemorrhage resulted fatally.

Metastasis from angiomas is exceedingly rare; there are only a few cases on record. Borrmann cites a case of recurring angioma of the left wall of the chest; the tumor later extended to the lung, causing death by the formation of multiple foci. Ewing describes a somewhat similar case of a bulky cavernous angioma of the skin and mucous membrane which metastasized to the lungs. Shennan reports a case of a girl of twenty-three years with multiple nevi of the skin. She had a history of hæmoptysis and splenomegaly of six years' duration. Death resulted from thrombosis of the mesenteric vessels, and at necropsy multiple angiomatous nodules were found in the spleen, lungs, thymus, and bone-marrow.

Rokitanksy, Virchow, and Kaufmann have all said that angiomas of the gastro-intestinal tract are extremely rare. Virchow,[14] in his exhaustive work "Die Krankhaften Geschwülste" mentions only one case, an angioma of the jejunum, the specimen of which is in the Guy's Hospital Museum. Kaufmann cites a case of cystic angioma of the rectum.

Patients with hæmangioma of the stomach and intestine not infrequently present alarming symptoms which suggest an unfavorable prognosis, and contrast markedly with the excellent result which may be obtained by surgical intervention. Symptoms may indicate the presence of these tumors since early life. It is only when the tumor reaches such a size as to cause obstruction, or when its presence is revealed by sharp hemorrhages, that these patients seek treatment.

Angiomas of the intestine are rare; they may be multiple and accompanied by similar growths on the cutaneous surfaces. Winternitz and Boggs report a case of multiple angiomas of the intestinal tract, associated with multiple cutaneous angiomas. Gascoyen records the case of a man, aged forty-four years, with numerous nevi in the serosa of the intestine and an angioma of the neck. Angiomas of the stomach are pedunculated and freely movable; they generally occur in the pars media on the posterior wall or greater curvature and are covered completely with gastric mucosa. Ulceration is rare, but when it occurs, it is not infrequently the source of profuse hemorrhage. Very little distress results from the tumor, except that due to bleeding or obstruction. Occasionally these growths attain a large size.

Burty reports the case of a woman aged fifty-eight, who had had moderate pains and a sense of movement in her abdomen for a few months. At operation, a pedunculated angioma two kilograms in weight was found attached to the outer wall of the stomach projecting into the pelvis. A short history of acute symptoms is typical, although in some cases evidence of a tumor may have existed for a long time. Sherrill reports a case of a woman, aged thirty-one, who had a five-year history of decreased appetite and attacks of indigestion with vomiting. Symptoms had started following trauma to the abdominal wall. Pain in the epigastrium was almost constant, and was at times relieved by food. The patient vomited blood several times and

occasionally had tarry stools. Her hæmoglobin was only 30 per cent. A palpable mass, then present in the abdomen, gradually increased in size during the next five years. At operation an angioma with a broad pedicle was found attached to the greater curvature of the stomach. This was removed, together with a portion of the stomach. Gusez reports a case of angioma of the cardiac end of the stomach observed through the œsophagoscope. The patient had lived only on bread and wine for twelve months. There had been no bleeding or emesis. During the last four months he had had extreme difficulty in swallowing. The œsophagoscope was passed and a vascular tumor four centimetres in diameter was found in the cardiac end of the stomach. Treatment by dilatation with bougies and the application of radium gave an ultimately satisfactory result. It is impossible to say definitely that this growth was an angioma, as the diagnosis was not verified microscopically. Stockis [12] found at necropsy a small hæmangioma near the cardia on the lesser curvature of the stomach, in an infant who died following convulsions, shortly after vomiting blood and passing tarry stools. Lammers also reports a case of gastric hæmangioma found at necropsy. The tumor, which was two cm. in diameter and bulged into the stomach cavity, was attached to the posterior wall of the stomach by a broad base. Histologically, it was composed of moderately dilated capillaries, most of which had walls a single cell in thickness.

REPORT OF CASES

CASE I (A258233).—Dr. E. R., aged sixty-seven years, came to the Clinic January 28, 1919, complaining of epigastric distress. Six months before he had had a period of severe diarrhœa with frequent tarry and bloody stools. Following this attack, and again two months before examination, he had had persistent epigastric pain severe enough to keep him awake. A milk diet increased his discomfort, but bismuth gave him relief. During the past six months he had lost twenty-five pounds and felt very weak. His appetite had been good and food gave some relief, although recently eating had produced a sense of discomfort and fullness in the epigastrium. There had been no vomiting or bleeding.

The patient, who was fleshy, had a dilated aorta, and a blood-pressure of 240, was obviously a poor surgical risk. The urine contained a small amount of albumin and the Röntgen-ray revealed a filling defect in the body of the stomach, interpreted as due to a malignant growth of questionable operability. In view of the Röntgen-ray diagnosis, the location of the tumor, the patient's age and hypertension, surgical intervention was not advised. The patient specially requested operation.

A movable lobular mass was found on the posterior wall of the stomach. A sleeve resection was done with removal of eleven centimetres from the middle portion of the stomach, including the tumor. The stomach was closed by an end-to-end anastomosis. Two months later the patient reported his condition to be very satisfactory.

The tumor, six centimetres in diameter, was covered with thinned-out mucosa. On section it appeared blue-black and was divided into small lobulations by septums running in from the surrounding fibrous capsule. The growth was circumscribed and did not project out into the surrounding tissues. Histologically, it was com-

FIG. 1.—(Case A258233). Extensive filling defect on the posterior wall on the pars media of the stomach.

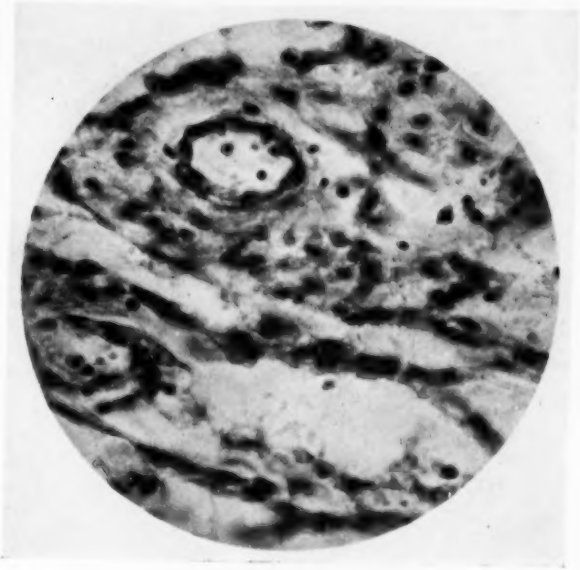

FIG. 2.—(Case A 258233). Interlaced mass of fine blood-vessels, some containing blood-cells. (X200).

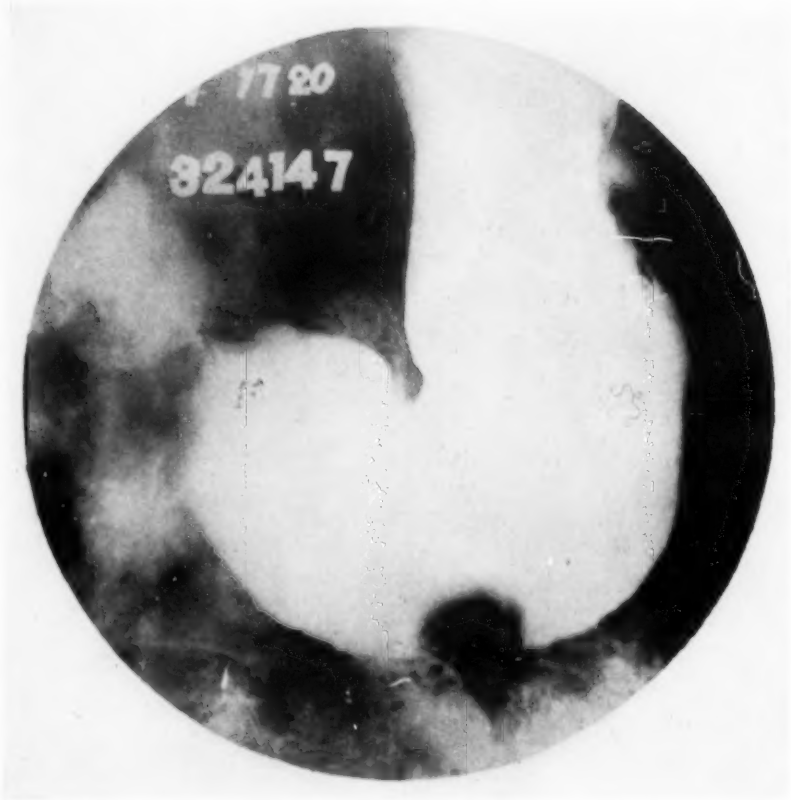

FIG. 3.—(Case A 324147). Clearcut filling defect on the greater curvature of the stomach.

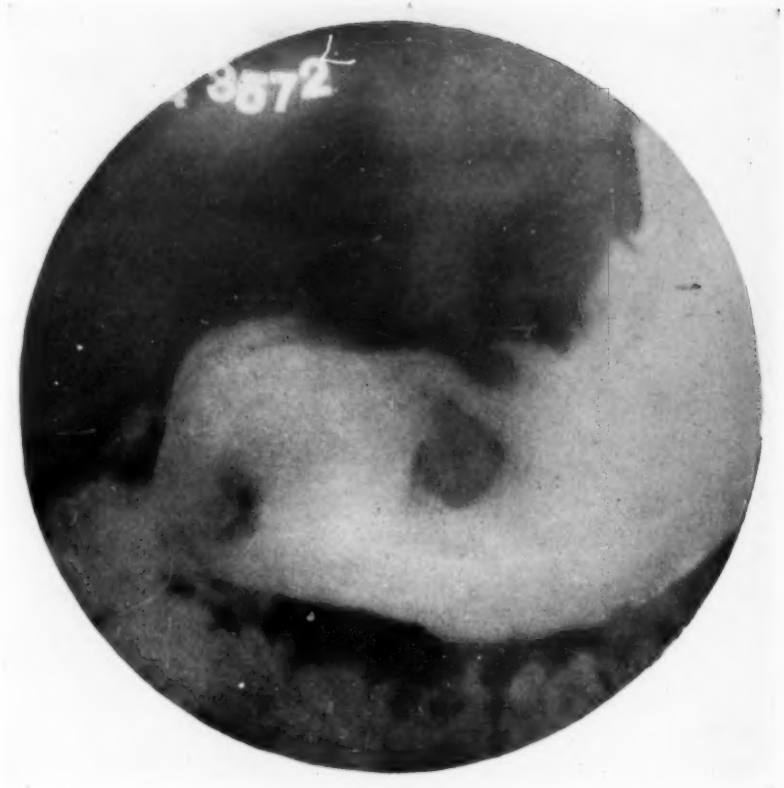

FIG. 4.—(Case A 343572). Filling defect on the posterior wall of the stomach.

FIG. 5.—(Case A 345572). Blood sinuses embedded in solid mass of endothelial cells and fibroblasts, located directly below gastric mucosa. (X40.)

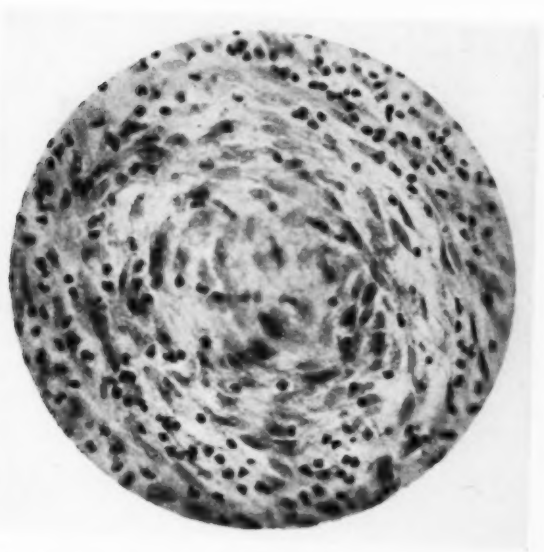

FIG. 6.—(Case A 345572). Extensive proliferation of endothelial cells and fibroblasts following obliteration of capillary vessel. (X250.)

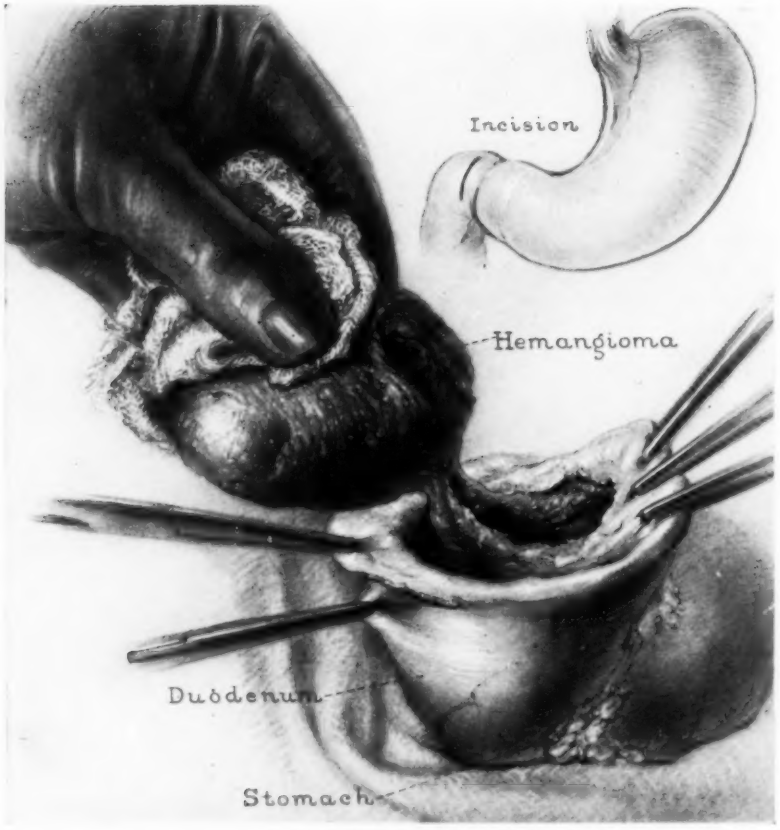

FIG. 7.—(Case 356641). Line of incision into duodenum and removal of angioma together with portion of mucous membrane.

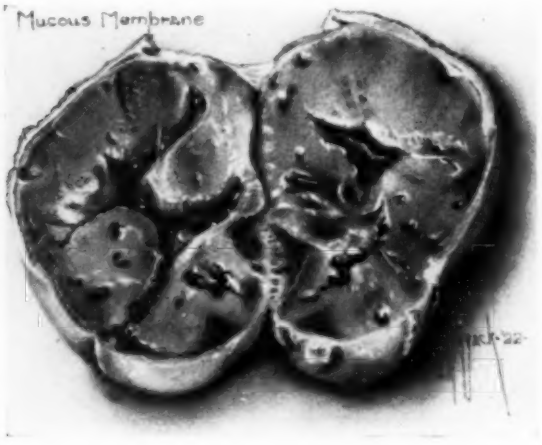

FIG. 8.—(Case 356641). Soft homogeneous structure of hæmangioma of duodenum.

posed of multiple capillary vessels, supported by a compact cellular stroma. The vessels were of various sizes, the majority having walls composed of several layers of cells. A few large thick-walled vessels were seen. In most cases the larger vessels and sinuses were filled with red blood-cells. In some areas the vessels and sinuses were in close approximation to one another, with only a few layers of cells between. There was moderate fibrosis throughout, but only very slight formation of endothelial whorls so often seen in this type of growth (Figs. 1 and 2).

Case II (A324147).—Mrs. H. B. S., aged twenty-five, came to the Clinic July 12, 1920, on account of indigestion which first began six years before. Following the birth of a baby in 1918, the patient had had a period of partial relief. In 1919 her epigastric discomfort recurred. She experienced an almost constant sense of fullness and distress in the upper abdomen. During the past year she had had frequent periods in which her stools were tarry and she had lost twenty pounds in weight. Five months before, and several times since, she had vomited large quantities of blood.

Physical examination was negative and the gastric analysis showed normal acid values. The Röntgen-ray examination revealed a lesion on the posterior wall of the stomach. A diagnosis of benign tumor or gastric ulcer was made.

At operation a smooth, rounded pedunculated tumor was found attached to the posterior wall of the stomach. The area of attachment was excised, two centimetres of mucosa being removed on each side of the tumor, as the stomach was large and sagged considerably. The opening in the stomach was sutured with chromic catgut and silk.

The tumor, two centimetres in diameter, was reddish-blue in color and was capped by a dimpled, eroded tip. It was soft and covered by normal mucosa. The cut section was smooth, vascular and somewhat homogeneous in appearance. Histologically, the most striking feature of the excised tumor was an overgrowth of endothelial cells. There were many small sinuses separated by a few strands of fibrous tissue. From the lining walls of the sinuses, the endothelial cells grew into the lumen in groups and in papillary buds, in some cases to such an extent as to fill the cavity completely. There was only moderate fibrosis and none of the commonly occurring endothelial whorl-formations. It was only on the borders of the tumor that a number of small branching capillaries could be seen. Most of these were composed of a single layer of cells. The fine capillaries served as the centre of the fibrosis which in some instances formed the framework of the larger masses of endothelial cells (Fig. 3).

Case III (A343572).—Mr. S. S., aged fifty years, came to the Clinic December 13, 1920. For the past year he had been short of breath and had tired very easily, being unable to climb one flight of stairs without stopping to rest. His appetite was good and his bowels were regular. During the past six months he had had occasional attacks of diarrhœa, and vomiting shortly after eating, and had at times experienced a sense of fullness two to three hours after meals.

Physical examination revealed nothing abnormal. The hæmoglobin was 44 per cent., and there were 3,500,000 erythrocytes to the cubic millimetre. The fæces contained blood and pathogenic amœba which probably accounted for the diarrhœa. The gastric contents did not contain free hydrochloric acid and only a small amount of combined acids. The Röntgen-ray examination showed a filling defect in the pars media of the stomach interpreted as due to a malignant growth.

At operation the stomach was found to contain a rounded, movable tumor. A perpendicular incision was made through the wall of the stomach which revealed a pedunculated, elongated tumor arising from the mucosa of the anterior

wall. The base of the tumor and about two centimetres of normal mucosa were excised. The stomach was closed with chromic catgut and silk.

The tumor was sausage-shaped, eleven centimetres by three centimetres. The tip was eroded and ulcerated, which explained the bleeding and anæmia, and very possibly formed the centre of tumor extension. The growth was covered with thinned-out mucosa. Histologically, it was made up of masses of endothelial cells and fibrous whorls; scattered throughout the cellular ground-work were numerous small sinuses and dilated capillaries. Most of these were lined by a single row of endothelial cells with large bulging nuclei. Often these cells budded both into the lumen of the vessel and on the outer surfaces. Very few capillary buds or fine capillaries were seen. The process at the time of removal was apparently of long-standing and quite inactive (Figs. 4, 5, and 6).

Case IV (A356641).—Mrs. B. C., aged twenty-two years, came to the Clinic April 28, 1921, complaining of chronic dyspepsia since childhood. She was nervous and excitable, and any dietary indiscretion had always produced nausea and epigastric distress. These attacks started with headache and upper abdominal discomfort, generally coming on about two hours after meals and relieved several hours later by vomiting of sour gastric contents. Recently she had several attacks of severe abdominal pain which were preceded by the usual dyspeptic symptoms.

Physical examination was negative. Hæmoglobin was 65 per cent. Gastric analysis revealed normal acid values with hypersecretion. On Röntgen-ray examination, the duodenum was shadowed as a ring with a translucent centre suggesting a polypoid growth. A diagnosis of a possible benign tumor of the duodenum was made.

At operation a thick-walled dilated stomach was found, the pylorus was wide open and on the duodenal side there was a rounded tumor completely filling the duodenum. A transverse incision was made and the tumor exposed. The mucous membrane was incised over the tumor and it was readily enucleated. The mucosa was sutured and the opening in the duodenum closed with two rows of chromic catgut and one of silk.

The tumor was three centimetres in diameter. It was soft and the cut section showed a colloidal hæmogeneous surface similar to a circumscribed thyroid adenoma of the fetal type. There were several large, thick-walled sinuses in the centre which divided the tumor into lobulated areas. Histologically, the growth was made up of a mesh of fine capillaries with a few dilated sinuses supported in a highly cellular framework. There were great numbers of small vessels which grew at random and had lumina only slightly larger than the width of the nuclei of the endothelial cells composing the vessel wall. Many of these capillaries were filled with erythrocytes. Branching and budding of the vessels were common, many of the short branches terminating blindly. There was very little fibrous or whorl formation; the growth was apparently a rapid and recent process (Figs. 7 and 8).

COMMENT

The most striking clinical feature of these cases is the excellent result obtained by surgery, markedly in contrast to the unfavorable pre-operative outlook. In two of these cases the Röntgen-ray examination and the patient's age indicated a malignant lesion in a possibly inoperable stage and location. The general good health of the patient, the normal acid values of the gastric secretion, and good digestive ability indicated the possibility of a benign

lesion. In two of the cases, the early age of the patient and the long-standing history were also in favor of a non-malignant growth.

A knowledge of these conditions and a differentiation from various clinically similar neoplasms is of distinct prognostic importance.

SUMMARY

Angiomas of the gastro-intestinal tract are rare and may simulate malignant conditions. When they occur in the stomach, they are generally found on the posterior wall in the common location for malignant conditions.

Similar to other benign tumors of the stomach, angiomas are occasionally found in young persons. There may be no definite gastric upset, the main complaint being weakness and epigastric discomfort. The acid values of the gastric secretion are generally normal and the general condition of the patient is usually much better than that of the patient with a similarly located malignant lesion.

Angiomas of the stomach, while generally small, may grow to a very large size. They are usually soft and covered with mucous membrane. Histologically, they are composed of fine blood-vessels and masses of fibroblasts and endothelial cells.

At the Mayo Clinic three patients with angioma of the stomach and one with angioma of the duodenum have been operated on in the past two years; two of the patients were young, and two were of cancer age. The advanced age of these two patients and the Röntgen-ray findings, similar to those in malignancy, suggested inoperable malignant lesions.

In all cases the tumor was removed and operation was followed by an excellent immediate and late result.

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MODIFICATION OF THE KADER OPERATION BASED ON THIRTY-TWO GASTROSTOMIES*

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It is really more the purpose of this paper to bring before the medical profession the increasing demand for gastrostomy and not to emphasize the slight modification of an already existing operation.

The operation of gastrostomy was first proposed in 1837 by Egbert and the first operation is credited to Sedillot who performed it in 1849. The present mortality is 20 to 25 per cent. in malignant cases, and 8 to 10 per cent. in non-malignant cases (DaCosta's Modern Surgery, 8th Ed.).

Gastrostomy is indicated in cases of cancer of the œsophagus, œsophageal stenosis due to compression, cicatricial changes, trauma, perforations and certain malformations of the œsophagus. It has been recommended as a preliminary procedure in œsophageal diverticula and in resection of a portion of the œsophagus.

The choice of time for the performance of a gastrostomy is of importance in that it very greatly influences the prognosis. It should be done before dehydration has manifested itself and while the patient is still able to swallow liquid food. Our two fatalities in the carcinoma cases were practically in a terminal condition from a state of dehydration. When these cases are operated upon before nutrition is absolutely at a standstill and before the patient is calling on his own body for nourishment, we do not believe that the operation affords any great danger.

We have to report thirty-two cases upon which we performed the operation of gastrostomy. These cases are divided into carcinoma of the œsophagus (of which we had sixteen cases); lye strictures (which numbered fourteen); one case of congenital stenosis of the œsophagus and one case of tracheo-œsophageal fistula.

Method of Operation.—In carcinoma cases, under local anæsthesia, an incision is made at the upper margin of the left rectus muscle, four inches in length. The stomach is exposed and identified, as the transverse colon presents itself more frequently than the stomach. A stay stitch is placed in the stomach and the stomach drawn through the incision. The level of the cardiac entrance to the stomach is noted and a point to the left of the cardiac entrance is chosen. The stomach wall is divided down to the submucous membrane through a very small incision. The mucous membrane is picked up with a small rat-tooth forceps through this opening. The blood-vessels are ligated before the mucous membrane is divided just large

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enough to admit a 22 French soft-rubber catheter. The catheter is fixed with a number one catgut stitch so that three-eighths of an inch of the catheter is permitted to pass into the stomach cavity. We think the advantages of this very small opening are: prevents hemorrhage, elimination of the hæmostatic stitch layer, it lessens the possibility of leakage of the stomach contents, and prevents regurgitation of liquid around the catheter. One or two purse-string stitches are placed around the tube. From now on the object is to throw a diamond shaped fold of the stomach wall around the tube, the upper and lower points of the diamond toward the greater and lesser curvature respectively, with the tube in the centre of the diamond. Lembert stitches are used so that a small fold is thrown distal to the tube at the points of the diamond which are one to one and a half inches on each side of the tube. As the tube is approached a larger surface is included in the stitch, so that at the level of the tube, the greater area of the stomach is included in the stitch and thrown around the tube.

The wall of the stomach is then attached to the parietal peritoneum. We have found this step necessary as a great many patients after they have been discharged from the hospital permit the tube to remain out too long and it is then necessary to dilate the channel. Such dilatation is effected by passing a probe through the opening and using uterine bougies of increased calibre to bring it up to the proper dimensions. If the stomach has not been fixed to the parietal peritoneum, this is much more difficult. Very often after gastrostomies, even in carcinoma cases when the œsophagus has been at rest for several weeks, the patients find they can again swallow and abandon the use of the tube.

While the above procedure may not seem to be necessary to the average surgeon who does the occasional gastrostomy, we have found that in the lye strictures, particularly in children where the stomach is found shrunken, it has been necessary to approach the fundus and use the diamond-shaped area in order to get a proper channel for the passage of the tube.

Post-operative Treatment.—It has been suggested by some authors that following this operation the patient should not receive any fluids through the gastrostomy tube for several hours. We do not think this precaution necessary. All our cases are fed three or four ounces of salt solution at the time of operation and every three hours subsequent thereto. Beginning the second day, three ounces of peptonized milk are given every three hours. The diet is gradually increased up to twelve ounces every three hours. At the end of the first week thin cereals, mashed potatoes, vegetables (which have been put through a sieve) are forced through the tube with a syringe. The fats are supplied in the form of butter and olive oil. Fruit juices are given daily and sugars are added to such foods as would require sweetening if taken by mouth. It has been observed by many authors that patients who are fed through gastrostomy tubes do not maintain the same degree of nutrition as those who swallow their food. The lack of psychic gastric

secretion has led to the preliminary mastication of the food before introduction through the tube into the stomach. This method is often very repulsive and is not usually carried out.

Dr. William H. Spencer has advanced the thought that the imbalance was due to the loss of saliva. We must realize that the salivary glands secrete from 1500 to 2000 c.c. in twenty-four hours, which are unconsciously swallowed, and which contain a stimulus in the form of a hormone, an enzyme or an activator, and which are entirely lacking in these cases in which complete stenosis is present. This condition has been obviated by the introduction of saliva into the food in the younger cases of cicatricial stenosis and a much more rapid improvement has been noted.

It was also observed that patients with stenosis of the œsophagus expectorate a great deal more than the normal individual. The saliva should be collected in sterile bottles, and the nose and bronchial secretions eliminated as much as possible and oral asepsis maintained in order that no infective material may be introduced into the stomach.

Concerning the tracheo-œsophageal fistula. We have operated upon one case of this type and there are 146 cases in literature. The mortality following gastrostomy in this condition is 100 per cent., the deaths occurring as a result of bronchial pneumonia due to the regurgitation of food through the cardiac opening from the œsophageal fistula into the lungs. From the literature, sixteen of these cases have been operated upon.

I would suggest in all future operations, in order to prevent the regurgitation of food through the cardiac end of the stomach, that the stomach be drawn through the abdominal incision and divided near the cardiac end; the distal or stomach end of the division closed and a gastrostomy performed in the usual manner. Through the open œsophageal end a catheter should be introduced which passes through the cardiac opening of the stomach into the œsophagus. This artificial fistula ought to be made water tight by purse-string stitches around the tube. The object of this tube is, of course, to permit the œsophageal secretions and any secretions that pass the congenital fistula to have a point of drainage. We believe that with this procedure the life of the patient can be prolonged so that reconstruction work can be done upon the fistula.

The mortality of our carcinoma cases is two deaths in sixteen cases. Two deaths, one each in congenital stenosis and tracheo-œsophageal fistula; and no deaths in fourteen cases of lye stricture.

The lye stricture cases were performed under general anæsthesia, although there is no objection to using local anæsthesia, and it is to be recommended in cases of water starvation. The tracheo-œsophageal fistula case was operated upon the second day of life under local anæsthesia, lived several days and died of broncho-pneumonia.

I am indebted to Dr. J. Chalmers DaCosta and to Dr. Chevalier Jackson, upon whose services these cases were admitted to the Jefferson Medical College Hospital.

OBSERVATIONS ON THE TREATMENT OF ACUTE PERFORATIONS OF THE STOMACH AND DUODENUM WITH REFERENCE TO GASTRO-ENTEROSTOMY

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Acute perforations of the walls of the stomach or duodenum are usually found in those areas which are the site of election for chronic ulcer. When independent of any foreign body or other traumatic agency the perforations can occur (1) either as part of the biological phenomena of ulcer, or (2) as an independent lesion.

1. In the latter eventuality the perforation, in its cause, mechanism and subsequent history, resembles in all particulars that of an embolic perforation of the appendix. That such perforations do occur in the wall of the stomach or duodenum is amply borne out by surgical experience and the experiences are further corroborated by much experimental work, especially that of Rosenow and others in the elective localization of bacteria in human disease. It is of much interest to note that the percentages of occurrence of the various lesions—and especially of perforations in the stomach, duodenum, appendix, etc.—correspond fairly accurately with the percentage numbers of similar lesions as they occur spontaneously in disease.

In human pathology such acute perforations, when their surgical treatment is followed by recovery, are distinguished by an absence of post-operative symptoms of any kind which ordinarily follow in many of the cases of stomach or duodenal ulcer. In this regard the subsequent post-operative history of perforation resembles that following operation for perforation of the appendix; the recovery is complete and rapid and, except for certain emergencies, such as obstruction, the post-operative period is devoid of any symptoms.

In cases of this kind the absence of symptoms subsequent to operation has important relations to the unimpaired functional capacities of the stomach. In a stomach in which an acute perforation has occurred independently of any preëxisting ulcer I have been several times able to show that after operation all of the gastric functions are within the normal limits. Inasmuch as many of the post-operative symptoms in cases of unperforated chronic ulcer are undoubtedly due to disturbances of physiology for which there has been insufficient compensation, it is only natural to expect in the cases of simple perforation in which no disturbance of function is present or follows subsequently, that no post-operative symptoms of any kind ought to appear.

2. Penetration of the wall of the stomach or duodenum through the base of an old-established ulcer and when the nourishment of the patient is at par, results from the gradual progression of the pathological process and is invariably accompanied by the formation of dense protecting adhesions around the lesion on the peritoneal side of the stomach or duodenal wall which

effectually lead to a safe walling off of the ulcerating and penetrating area and to the prevention of any sudden outpouring of gastric or duodenal contents into the free peritoneal cavity. Cases of this kind are common knowledge to any operating surgeon. They are especially frequent on the lesser curvature and posterior wall of the stomach and the lesions are very apt to become adherent to the body of the pancreas. Penetration of this kind is also common in gastrojejunal and jejunal ulcer; in these cases the penetration may occur into a neighboring hollow viscus, especially the stomach and the transverse colon.

A sudden perforation into the free peritoneal cavity through the base of an old-established ulcer, under the conditions just described, is indicative of a lack of healing power on the part of the individual. I think that such acute perforations are very uncommon in ulcers of the stomach or duodenum; and I believe that the conditions of nourishment, etc., which would be necessary for an acute perforation to occur through the base of an established lesion are most apt to be present in long-standing gastrojejunal and jejunal ulcer.

In some of the cases of old-established ulcer, however, the mechanism of the acute perforation may be independent of the state of nourishment or of the healing power of the individual, and it then is similar to that which causes the occurrence of acute perforation in the absence of any preëxisting lesion. Here, too, it assumes the characteristics of an embolic phenomenon in the base of the ulcerating defect; it occurs during the course of some temporary bacteriæmia the reasons for which may not be clinically apparent and the evidences of which are so transitory as to be undemonstrable.

Acute perforations through the base of an established ulcer are most common because of this embolic mechanism as opposed to any sudden perforation (penetration rather), due to the lack of nourishment and healing power. Perforations by the former mechanism are especially common in ulcers of the stomach and duodenum. The preponderance of this mechanism would also explain the comparative rarity of acute perforation traced to an established gastrojejunal or jejunal ulcer as opposed to perforations in established primary stomach and duodenal ulcers.

In many cases of this kind, which I have been able to study, it was possible to demonstrate that some disturbances of function existed subsequently to the operation which, undoubtedly, were a continuation of similar disturbances which had existed prior to operation. In some of the cases there was a history of previous dyspepsia; in others the perforation was the first symptom. In some, at least, of the latter, symptoms were undoubtedly present which were too slight to make any impression either because of themselves, or because of the hypæsthetic habitus of the individual.

The post-operative histories of these cases are noted by the fairly common occurrence of post-operative symptoms. In the reports of acute perforations of the stomach or duodenum, as ordinarily published, all of the cases noted

as having post-operative symptoms sufficient for further treatment belong in this group. The facts outlined in the previous paragraph furnish adequate criteria for their explanation, either when the symptoms are due to functional causes or when they are due to the persistence of the primary lesion or to the appearance of new ulcerations in the stomach, the duodenum, at the stoma of a gastro-enterostomy or in the jejunum.

There are apparent exceptions that occur in both of these groups. Those in the first group (embolic mechanism without previous ulcer) are easily explainable. On previous occasions I have gone over the etiology of "peptic" ulcer. From all of the available information it seems that acute defects can appear in the wall of the stomach or duodenum in a number of various ways and because of more than one agency. These all have the important characteristic of undergoing a rapid and spontaneous healing. Such acute defects correspond accurately in human pathology to acute perforations occurring in the absence of old-established ulcers. Apparently some of these acute defects can on occasion assume a chronic protracted course and lose their ability to heal; and, while the cause which determines the refractoriness to healing is not known, it is fairly well established that it must be some definite agency which in most of the cases becomes superimposed on the original mechanism of the acute defect. Here we have the explanation for any of the cases in the first group (acute perforations in the absence of any previous ulcer) which subsequently develop symptoms and in which an ulcerating lesion can subsequently be demonstrable at operation or autopsy at the site of the perforation; the acute defect of the perforation loses its ability to heal because of the superimposition of the agency causing "chronic ulcer." It is conceivable, too, that this latter agency may have also been able to have caused the original defect. Under such conditions a case in the first group (embolic perforations in the absence of ulcer) becomes one of the second group (embolic perforations in the base of an established ulcer).

The exceptions in the second group (perforations through old-established ulcers) are explainable on the basis of remissions of symptoms to which chronic ulcer of the stomach or duodenum is notoriously subject.

The dictum that the accident of perforation is a natural form of cure for ulcer of the stomach or duodenum is fallacious; this can be readily inferred from the facts previously outlined. The fact that no post-operative symptoms appear after the successful closure of an acute perforation simply means either that no true ulcer was present but simply an embolic lesion, or if an ulcer were truly present, that the latter was in a stage of remission which, perhaps, was protracted to a longer interval than is usual.

I go over these essential characteristics of perforating lesions of the stomach and duodenum so minutely, because they seem to me to be of great significance in the determination of the proper methods of therapy. It must be apparent to every one that one is dealing here with two distinct lesions (1) A simple acute perforation; and (2) an ulcerating defect in which an acute

perforation is an unlooked-for emergency, even though it be one of the well-recognized phenomena of ulcer. Naturally while the immediate closure of the perforation is the sine qua non of success in either and every case, the advisability of any further addition to this essential is subject to argument, especially when practised in the cases of the first group (simple perforations) as opposed to those in the second group (perforation through an ulcer base).

The one addition to the simple closure of the perforation about which much has been, and is being written and said, is gastro-enterostomy. The best surgical opinion to-day does not consider any other more radical measures as permissable additions to the closure of the perforation. Surgical opinion is practically unanimous in asserting that the addition of gastro-enterostomy is devoid of any additional risk, as far as danger to life is concerned, when the patient is operated upon while still in satisfactory condition. So that in any discussion about the propriety of adding gastro-enterostomy to the closure of the perforation, this factor may be excluded as being a constant.

Much of the discussion concerning the addition of gastro-enterostomy has arisen because of the fact that in a certain number of the cases of acute perforation symptoms occur subsequently to operation which can be directly attributed to the presence of an ulcerating lesion. Arguing from this point it has seemed to some men that the addition of gastro-enterostomy would obviate any of the subsequent trouble. That is the foundation for the practice of doing gastro-enterostomy at the time of the primary operation for the closure of the perforation.

I am quite sure that every one will agree that if one could feel sure at the time the abdomen was open, that the lesion to be dealt with was a simple perforation, the question of doing anything further would not arise, inasmuch as such a lesion has nothing in common with chronic ulcer and no further disability would and need be anticipated. But the trouble is that while in a few cases the distinction can, perhaps, be made, in much the larger number the gross appearances give no inkling of whether the lesion is a simple perforation or a chronic ulcer plus a perforation. One is then in the position where one must say that the lesion which is exposed is not classifiable or one must assume for safety's sake that all of the doubtful cases are probably ulcer cases in which an acute perforation has been superimposed.

Under such conditions it seems to be beyond question that the propriety of doing anything further and the usefulness of the individual procedure chosen—whether it be gastro-enterostomy or any other recognized form of surgical endeavor—must be determined essentially upon the value of the chosen method of procedure as determined beyond reasonable doubt in cases of stomach and duodenal ulcer which are not complicated by the accident of perforation. If the given procedure be useless, or even of doubtful utility for the purpose of cure in unperforated gastric or duodenal ulcer, it stands to reason that it would be equally useless or of doubtful utility when the lesion was complicated by a sudden perforation.

Present-day opinion concerning the value of gastro-enterostomy has under-

gone considerable change. It has come to be recognized more and more that the method is wofully deficient; so much is this so that among surgeons of large experience gastro-enterostomy is avoided as much as possible and other procedures are substituted whenever the lesion and conditions lend themselves thereto. Gastro-enterostomy has fallen to second and even third place in the order of importance.

Present-day methods require other and more extensive procedures the performance of which would not be, perhaps, quite so innocuous of danger when they are carried out under the emergency conditions of an acute perforation. These include resections of various kinds or pyloroplasties. These ordinarily, as indicated previously, are not to be considered as additional procedures to the life-saving closure of the perforation.

In view of all of the facts outlined in this communication it seems to me that the most rational procedure in the presence of an acute perforation is to simply close the perforation. In a certain number this would be all that would ever be necessary. In others a course of medical treatment might be valuable before resorting to any extensive surgical operation. In still others, in which the continued presence or recurrence of post-operative symptoms would make it advisable, further surgical measures could be undertaken in the security of conditions not burdened with the risks of any emergency and with the added advantage of more prolonged pre-operative study and planning. Better and more adequate measures can thus be more securely employed.

A great deal is being said about combining medical and surgical therapy in the treatment of gastric and duodenal ulcer. Perhaps under no other condition of ulcer is this a greater possibility than after an acute perforation. I have made it a custom after closing the perforation to wait just long enough to be sure that the stomach will tolerate small amounts of food. Then the patient is immediately placed upon one of the recognized courses of medical treatment; most often I prefer the old Lenhartz régime from which all meat is excluded. This has given me most satisfactory immediate and late results.

DUODENAL DIVERTICULA*

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It is probably true that the great majority of duodenal diverticula give rise to few if any symptoms, and may be looked upon as unusual findings of little clinical significance, encountered in the routine röntgenologic examination of the intestinal tract. Yet it must be evident to every surgeon who has removed one or more of these diverticula that patients suffering from this condition are in constant danger. The walls of most of the pouches, especially if of any size, are composed only of mucous membrane with a thinned-out muscularis mucosa which may or may not be covered by peritoneum according to the location. That perforation does not occur more often is possibly due to the fact that most of them arise from the inner or posterior surface of the gut and are supported by the surrounding structures. There can be but little doubt that in most instances the anomaly is the result of a congenital defect, although a few cases are reported in which the sac formation has developed in the region of an healed ulcer, while still others give a history of trauma. The principal reasons for attributing these diverticula to congenital defects are that they have been found in infants, may be multiple, and are associated with similar changes in other parts of the alimentary tract. One of our cases showed one pouch in the lesser curvature of the stomach, two in the duodenum, and several in the small intestine and colon. The fact that they may be located in any part of the gut wall would indicate that weakened or deficient areas exist in the muscular coat at points other than those through which the vessels or ducts enter and emerge. Duodenal diverticula occur more frequently in women than in men. The average age in Case's [1] series of eighty-five reported cases is given as fifty-six. However, no conclusion can be drawn from these figures as to the probable duration of the symptoms prior to the time the patient consulted the röntgenologist. It would seem from the histories of our cases that they had developed to a sufficient extent to be of clinical importance at a much earlier period of life. That duodenal diverticula occur sufficiently frequent to be of more than passing interest is shown by the fact that röntgenologists of large experience report the incidence of the lesion in from one to two per cent.

The pathology of duodenal diverticula is very much the same in nearly all of the reported cases. They are referred to as thin-walled sacs, pouched or loculated—according to size—composed of mucosa and muscularis mucosa lined with a smooth epithelium which may show, as the result of distention, thinned-out areas, but not usually showing marked inflammatory changes. The muscular coat is practically absent in every specimen. The actual living

* Read before the Southern Surgical Association, December 13, 1921.

pathology as seen at operation is very striking. After freeing the sac from the surrounding fat and areolar tissue it will stand out, delimiting itself by the gas pressure from within. As the dissection is continued down to the neck an actual fenestration may be observed in the muscle layer of the gut wall. The arrangement of the structures is comparable to that of a true aneurism in which the intima has herniated through the outer coats of the vessel. The location of the duodenum in relation to the stomach, gall-bladder and pancreas is such that it is not possible to attribute to this anomaly a characteristic group of symptoms. Apparently there is little discomfort of consequence associated with the condition until the pouches reach considerable size and then only when the neck is sufficiently narrow to cause retention. The resulting symptoms would logically be ascribed to the more usual diseases of the upper abdomen, and could be interpreted only in retrospect after the barium meal.

The first indication that the duodenum is the seat of diverticula may be shown by the development of symptoms of an obstructive nature. Those situated in the first portion may at times interfere with the proper emptying of the stomach, in the vicinity of the ampulla of Vater they may cause biliary obstruction by pressure on the common bile duct, while those near the duodeno-jejunal angle may give rise to serious symptoms from pressure in that region. If the pouches become inflamed or rupture from overdistention, or from the presence of a foreign body, the local or general symptoms usual to such accidents will be present. In the type in which the sac retains large quantities of chyme, as shown by the barium meal, there may be periodic intestinal attacks of a toxic nature. Our second case gave symptoms of this sort, while the third presented the typical picture of an attack of acute dilatation of the stomach. A large proportion of the reported cases of duodenal diverticulosis have been situated in the second or descending portion of the gut in the vicinity of the ampulla of Vater. The next most common site is the first portion and the least common the horizontal or third portion. All four cases herewith reported were located in the third portion.

The Röntgen-ray offers the only means for the diagnosis of duodenal diverticulitis, and too much credit cannot be given to röntgenologists for pointing out this lesion and insisting upon its surgical importance. To Case and Cole especial credit is due.

The ideal treatment is complete removal of the sac by a surgical operation. As to whether this treatment should be advised in a given case, or whether it should be handled in a palliative or expectant way, depends upon the symptoms and location of the pouch. In the cases, giving symptoms, which with a fair degree of accuracy may be attributed to the diverticulum, operative treatment is indicated. Should the barium meal demonstrate the presence of a diverticulum in a patient suffering from chronic digestive disturbance, even if a definite lesion is found in the adjoining viscera, the diverticulum should be removed or infolded at the time the accompanying lesion is corrected, provided no distinct contra-indication exists such as inaccessibility

of the sac or poor condition of the patient. In the type of diverticulum with a wide neck, and without retention as shown by the Röntgen-ray examination, in which the findings may be classed as accidental (provided no other lesion is present), the question of operation may be deferred, especially in the aged. As experience is gained in the operative management of this lesion the natural anatomical difficulties encountered in exposing the sac will soon be met. The non-inflamed diverticula are not adherent and with ordinary care can be dissected from the surrounding structures without great difficulty or danger.

In one of our cases the pouch extended down beneath the mesenteric artery and vein, and in another, two pouches arising from the posterior surface of the third part of the duodenum extended to the right, below and posterior to the head of the pancreas. All three were removed successfully. With the aid of the röntgenologist not only the location of the neck, but the course of the pouch can be determined with considerable accuracy. In order to locate diverticula situated behind the peritoneum it may be necessary to freely mobilize the descending as well as the transverse and terminal portions of the duodenum. The pouches arising from the anterior surface or lower border will come immediately into view, but those originating in the upper border or posterior surface may be difficult to locate. The presence of air in the sac aids greatly in their recognition.

The operative procedure best suited for the relief of a given duodenal diverticulum will depend upon the size and location of the pouch. In those of small size invagination is the easiest and safest operation. The larger ones should be excised if possible. Should the lumen of the gut be narrowed to any extent by either of these procedures gastro-enterostomy should be added in the cases in which the diverticulum is situated in the first, second and proximal half of the third portions and duodeno-jejunostomy if in the distal half of the third portion or in the vicinity of the duodeno-jejunal angle. In the cases with obstructive symptoms, either of the common bile duct or gut, in which for one reason or another it is not possible to treat the sac directly, measures best suited to relieve the obstruction should be adopted. It may be necessary to drain the biliary tract by joining the gall-bladder to the stomach or intestine, or to unite the jejunum to the duodenum or stomach. In other words, proper drainage must be provided under any conditions. Fortunately the anatomical arrangement of the viscera in this region is such that this can usually be accomplished.

Four patients with diverticula of the duodenum have come under my care. In three the diagnosis was confirmed at operation. In each instance the lesion was situated in the third portion or at the duodeno-jejunal angle, in the fourth case the diagnosis was based upon the Röntgen-ray findings only. The first patient was operated upon for a supposed penetrating duodenal ulcer, although a duodenal diverticulum had been suggested by Doctor LeWald, the röntgenologist. No ulcer was found. There was general enlargement of the retroperitoneal glands, one of which was removed, showing Hodgkin's

disease. A search of the descending and transverse portions of the duodenum failed to explain the X-ray findings, but upon exposing the gut at the duodeno-jejunal angle a diverticulum about two centimetres in diameter was located arising from the upper posterior wall. No attempt was made to remove the pouch as sufficient pathology had already been found to explain the patient's symptoms. The second case was diagnosed by Doctor Cole as a large diverticulum of the duodenum. The diagnosis was confirmed at operation, and a diverticulum two and one-half inches in diameter was removed from the third portion of the gut. No other lesion found. The symptoms in this case were those of chronic digestive disturbance with acute exacerbations. In the third case, Doctor Imboden made a diagnosis of two diverticula arising from the transverse portion of the duodenum. He also found a single diverticulum high up in the lesser curvature of the stomach and multiple diverticula of the small and large intestine. The patient had suffered from a severe attack of obstruction high up in the intestinal tract. At operation two large diverticula were removed, and the presence of diverticula in the small intestine confirmed. No exploration was made of the stomach. No other lesion present. The fourth case was referred to the hospital for the relief of pain in the right side with the suggestion that the appendix was the cause. Doctor LeWald made the diagnosis of a diverticulum probably located in the terminal portion. At operation the gall-bladder contained a number of gall-stones. The gall-bladder and appendix were removed. A hurried examination failed to locate the diverticulum. As the patient was quite fat and sufficient explanation for the symptoms had been found, it was not deemed wise to prolong the operation further.

CASE I.—*Diverticulum of the Terminal Portion of the Duodenum. Confirmed at operation. Not removed.* S. V., aged forty-two. Admitted to St. Luke's Hospital, March 18, 1920. Transferred to surgical service, March 24, 1920.

Chief Complaint.—Vomiting and soreness in region of stomach. Duration, six months.

Present Illness.—Patient has had frequent attacks of vomiting coming on from every three to four weeks for the past six months. No relation to eating. No sharp pain but general soreness over the abdomen. Attacks usually last about one week. Appetite poor. Has lost weight and strength.

Past History.—Three years ago patient was treated for Hodgkin's disease and apparently was much improved. Family history negative.

Physical Examination.—Poorly nourished woman; swarthy type, appearing chronically ill. Examination negative except for tenderness in the right upper quadrant, and an enlarged gland in the right axilla.

Laboratory Findings.—Red blood-cells, 3,600,000; hæmoglobin, sixty-six per cent.; white blood-cells, 22,300; morphology, normal.

Röntgen-ray Examination.—(Doctor LeWald.) The stomach is markedly ptosed, "water-trap type." The first part of the duodenum is unusually high, extending up as far as the first lumbar vertebra. The greater curvature is four inches below the umbilicus. There is a peculiar shadow to the inner side of the pylorus suggesting the possibility of diverticulum of the duodenum.

Thirty-five minutes. The first and second part of the duodenum unusually prominent, suggesting the possibility of obstruction about the second portion.

Five hours, thirty minutes. The stomach is empty, also the duodenum, except for a shadow indicating retention in the diverticulum. Confirmatory examination is advisable.

Twenty-four hours. Some of the meal has reached the sigmoid. Traces of the meal remain as far back as the cæcum. The diverticulum of the duodenum is evidenced by a collection of gas.

Operation.—March 24, 1920. Pre-operative diagnosis, perforating duodenal ulcer. Post-operative diagnosis, diverticulum of the terminal duodenum. Retro-peritoneal Hodgkin's. Operation: Exploratory laparotomy. Removal of gland for diagnosis.

Pathological Findings.—Enlarged glands throughout gastro-hepatic omentum and along mesenteric artery. Stomach and duodenum, first and second portions normal. At the duodeno-jejunal junction a diverticulum was found about two cm. in diameter arising from the upper and posterior wall of the gut.

Operative Procedure.—Upper right rectus incision. Transverse and terminal portions of duodenum exposed by dividing transverse mesocolon. Diverticulum isolated but not removed, as sufficient pathology had been found in the extensive glandular involvement to account for the symptoms. Gland removed for diagnosis.

Pathological Report.—Hodgkin's disease, mesenteric node. Recovery following operation uninterrupted. Discharged from hospital, April 9, 1920.

CASE II.—*Diverticulum of the Third Portion of Duodenum. Excision.*—F. S., aged fifty-three. Admitted to St. Luke's Hospital, July 13, 1921.

Chief Complaint.—Chronic intestinal disturbance. Present illness, duration two years. Periodic attacks of abdominal pain and diarrhœa lasting about one week, coming on about every two months. Stools often contained mucus and blood. Attacks controlled by a restricted diet and large doses of bismuth. Dietary indiscretions seem to be the exciting cause of the attacks.

Past History.—Negative except for nervous breakdown two years ago following first attack of diarrhœa.

Physical Examination.—Well-developed and well-nourished female. Slight rigidity over upper left quadrant of abdomen. Otherwise negative.

Röntgen-ray Findings.—(Doctor Cole.) Type: orthotonic. Peristalsis: three cycle, equal on the greater and lesser curvatures, unobstructed. Systole and diastole shown distinctly. Ileum, jejunum, duodenum and cap shown distinctly. Connected with the descending duodenum is a very large pouch much larger than a hen's egg. This is observed during the early stages of digestion and also at two, six and twenty-four hours, and it is observed to be still filled with barium from the ingested barium meal three days after the administration of the meal, at the time the colon plates were made. It is approximately well filled at this time as it is in any of the plates. This indicates that the opening of the pouch is upward and not downward. The rest of the duodenum is apparently normal. Cap, normal and symmetrical, and corresponds with the pyloric end of the stomach. Sphincter, normal. Pyloric end of stomach expands and contracts in a normal manner.

From a study of these plates I believe one is justified in making a negative diagnosis of cancer or ulcer of the stomach and a negative diagnosis of ulcer of the cap. There is evidence of gall-bladder adhesions involving the cap of upper part of the descending duodenum.

There is a definite evidence of an immense duodenal diverticulum with its opening upward, which accounts for the prolonged retention of barium in this diverticulum. In spite of the fact that the stomach empties itself during the early stages of digestion there is slight retention of barium up to twenty-four hours and I believe that this retention is due to a regurgitation of the barium from the pouch into the stomach.

Operation.—July 18, 1921. Pre-operative diagnosis, diverticulum of the third portion of the duodenum. Post-operative diagnosis, same. Operation, removal of diverticulum.

Pathological Findings.—In the third portion of the duodenum a diverticulum was located arising from the anterior wall lying partly behind the mesenteric artery and vein. After freeing, the diverticulum measured about two and five-tenths inches in diameter, base three-fourths inch. Walls very thin, apparently composed of mucous membrane only.

Operative Procedure.—High right rectus incision. Transverse mesocolon in region of the third portion of the duodenum divided. Diverticulum isolated. Base clamped. Diverticulum excised. Opening in the mucous membrane closed by running purse-string suture of chromic gut, reinforced by two layers of chromic gut. Wound closed without drainage.

Röntgen-ray Examination—Post-operative.—(Doctor Cole, November 12, 1921.) A short series of the stomach made immediately and two hours after the ingestion of a barium meal shows the stomach to be of the same size, shape and position as it was at the previous examination. The jejunum, duodenum and cap and even the jejunal-dudoenal junction is shown distinctly, much more than it was at the previous examination. There is no deformity of the duodenum in the region from which the diverticulum was removed. The cap, sphincter and stomach are normal. At two hours the head of the column is in the terminal ileum.

Pathological Report.—The specimen when received in the laboratory had been distended with fluid and photographed. It is a thin-walled, fluctuating sac with coarse lobulations caused by fibrous bands constricting the surface, but not corresponding to any anatomical structures.

It measures 4 x 4 x 2.5 cm. in the greater diameters, resembling roughly a triangular pyramid in form. There is a line of over-and-over sutures at the pedicle which now measure 3 x 0.5 cm. The remainder of the surface is smooth, covered with peritoneum, and very delicate and fibrous adhesions. The surface vessels are moderately injected.

On opening the sac the wall is found to be uniformly about one-tenth cm. in thickness, low ridges separating the lobules. The mucosa, which is greatly stretched and thinned, shows a pale velvety surface with unbroken epithelium, but no trace of the normal plicas circulares, although some of the lobulations may have been found by them.

Microscopic sections were made from two areas. They show the same structures, consisting only of mucosa including the smooth muscle fibres of the muscularis mucosæ and the peritoneum. The mucosa as a whole is thinned, due to the chronic distention, and the villi correspondingly flattened, but the epithelium is fairly normal. No ducts of Brunner's glands are found, and as the serosa is applied closely to the muscularis mucosæ none of the glands are seen. The deeper portion shows a slight catarrhal process, distention of the epithelial cells with mucus, and moderate infiltration of the stroma. Lymphoid nodules, normal in type, are present.

Convalescence uneventful. Discharged from hospital, August 6, 1921.

November 15, 1921. Patient in excellent condition and is free from symptoms.

CASE III.—*Diverticula (2) of the Third Portion of the Duodenum. Excision.*—K. H., aged thirty-nine. Admitted to St. Luke's Hospital, November 12, 1921. Chief complaint, dull pain upper abdomen, followed by nausea and vomiting.

Present Illness.—Eight weeks ago noticed dull pain in the middle of abdomen. This pain gradually increased and was of a spasmodic nature. Attacks coming on every few hours. Forty-eight hours after onset became nauseated and vomited. General abdominal tenderness and distention. This attack of pain continued for

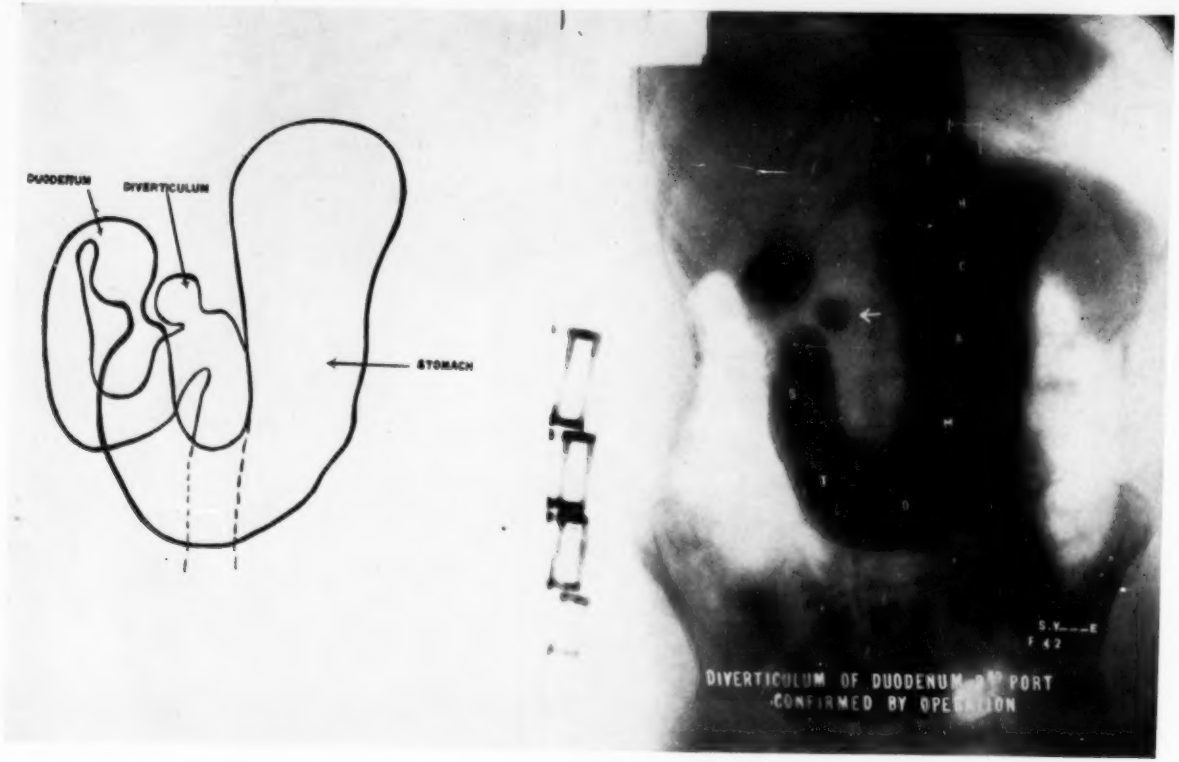

FIG. 1.—Case I. Diverticulum at duodeno-jejunal angle. Confirmed but not removed at operation.

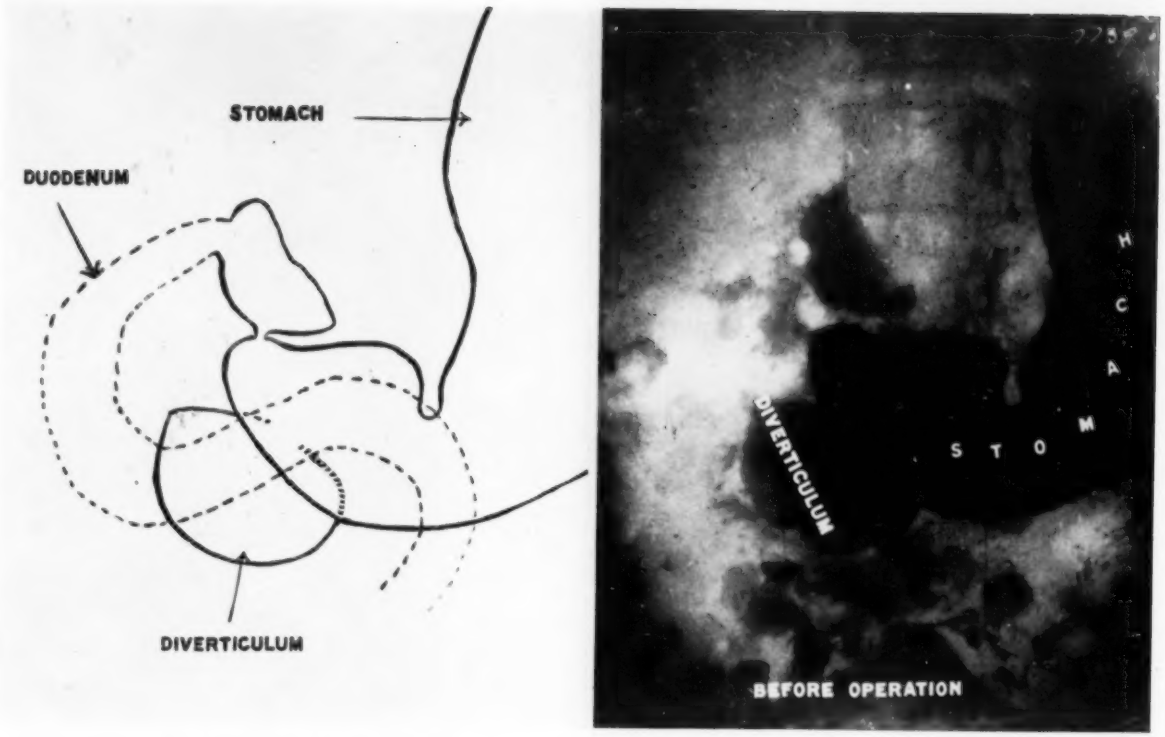

FIG. 2.—Case II. Large diverticulum, third portion of the duodenum. Removed at operation.

FIG. 3.—Case II. Diverticulum of duodenum. Seventy-two hours after bismuth meal. Colon injected.

FIG. 4.—Duodenal diverticulum, removed from Case II, July 18, 1921. (Slightly enlarged.)

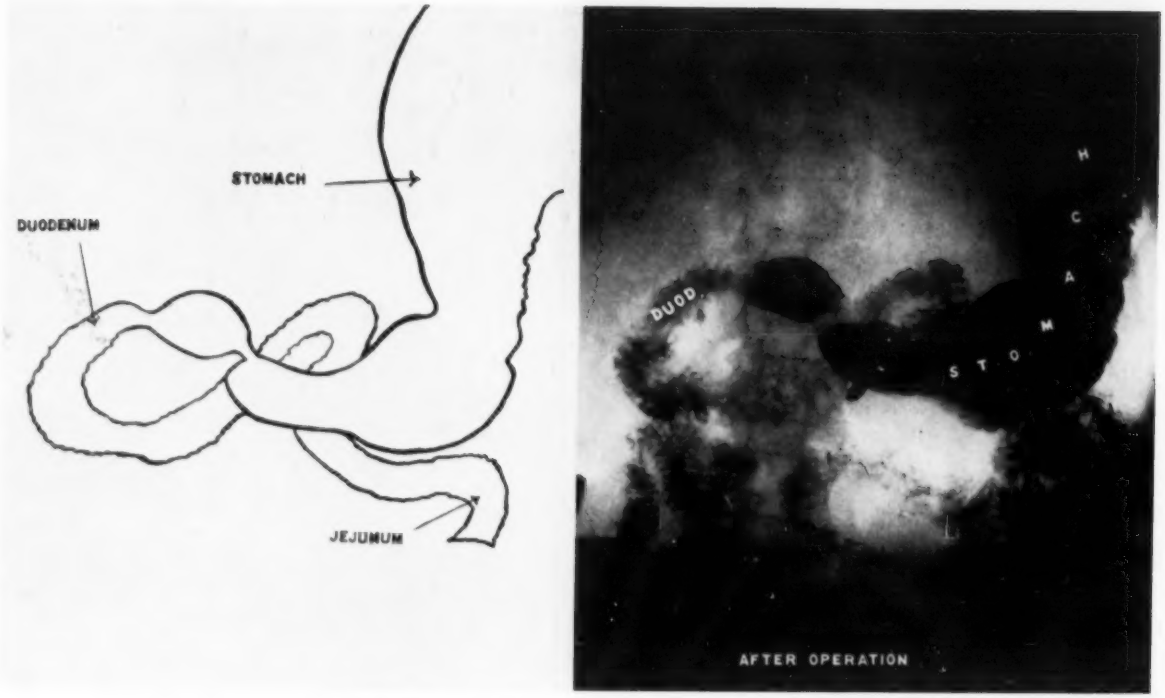

FIG. 5.—Case II. Three months after operation.

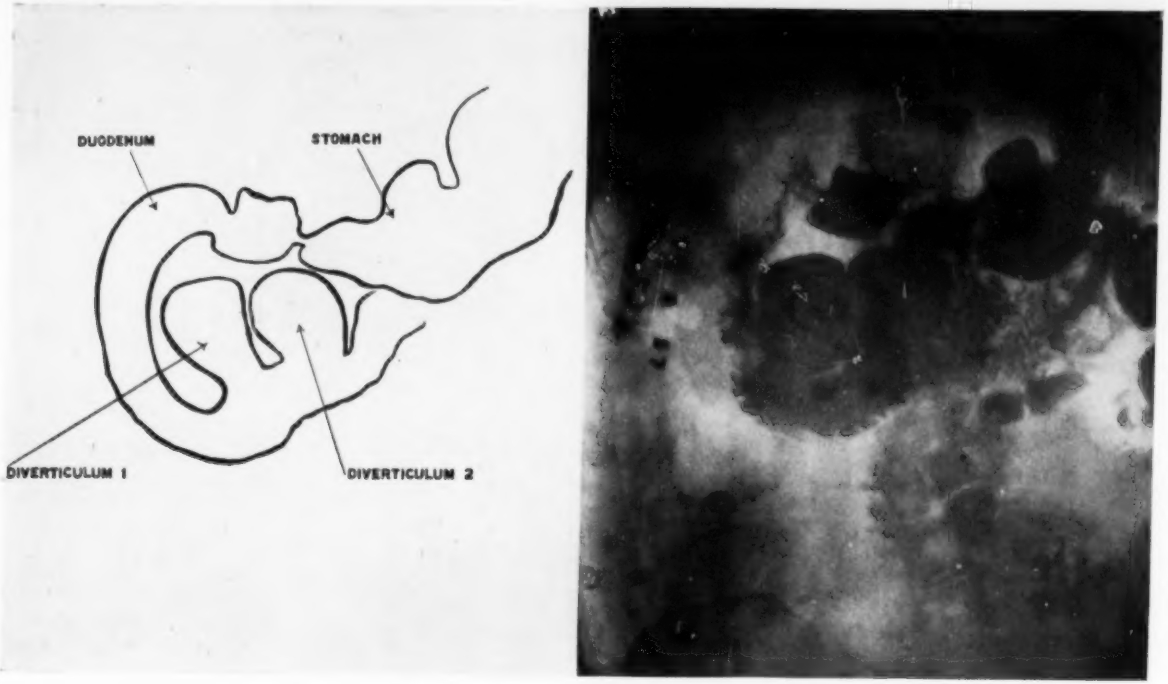

FIG. 6.—Case III. Diverticula (2) third portion of duodenum.

FIG. 7.—Duodenal diverticula. Removed from Case III, November 15, 1921.

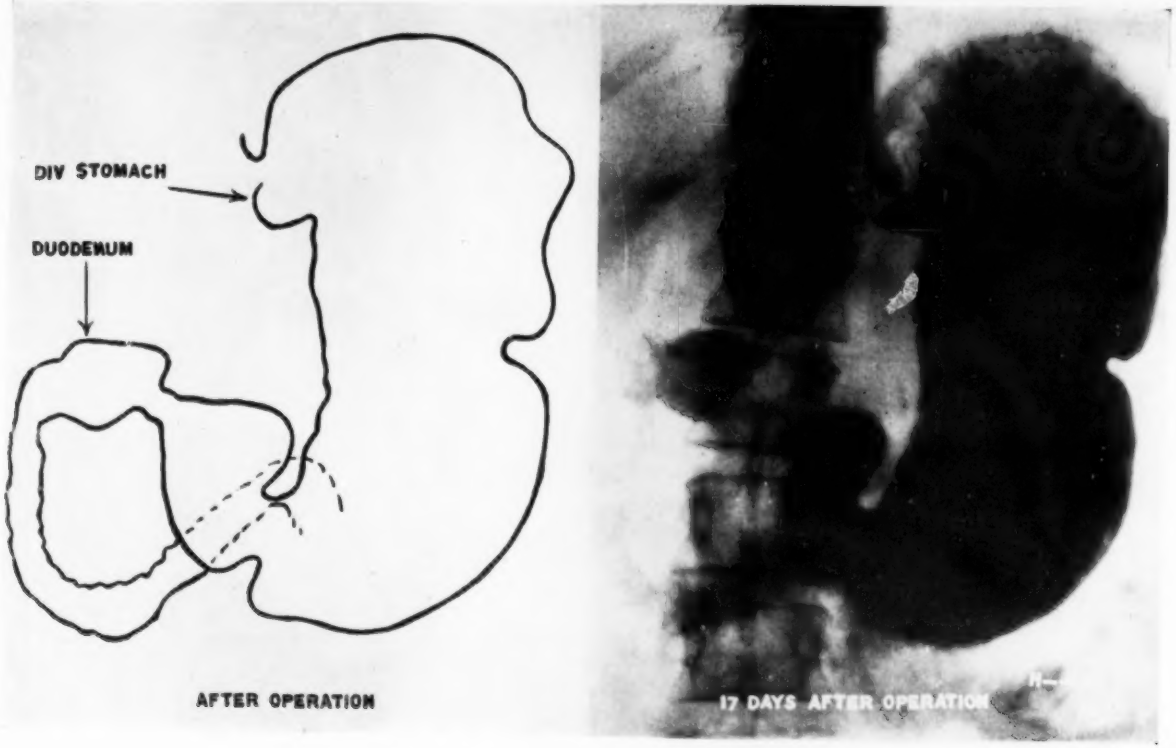

FIG. 8.—Case III. Seventeen days after operation.

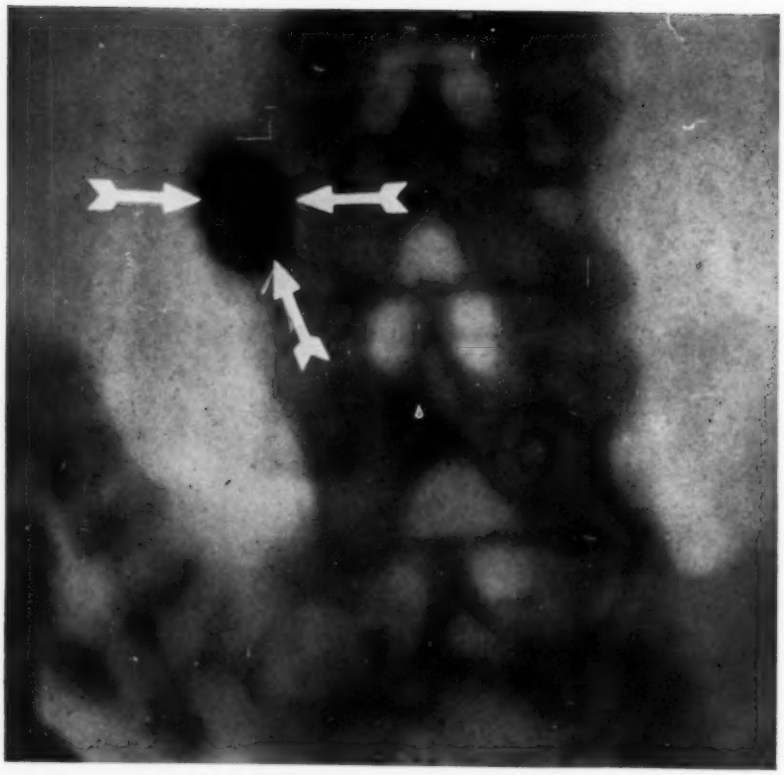

FIG. 9.—Case IV. Diverticulum, third portion, probably at duodenal-jejunal angle. Not confirmed at operation.

eight days and was finally relieved by washing out the stomach. During the attack there was no fever, jaundice or urinary disturbance. Since the attack subsided has felt as well as before attack, except for localized tenderness in the region of the umbilicus.

Past History.—Married, four children, no miscarriages. About seven weeks ago had several mild attacks similar to the recent one. Otherwise negative.

Physical Examination.—Well-developed, well-nourished woman. There is a slight tenderness in epigastric region—most marked in the ensiform of the middle line. Considerable gurgling in this region apparently due to distended viscera. Otherwise negative.

Laboratory Findings.—Red blood-cells, 4,900,000; hæmoglobin, 105 per cent.; white blood-cells, 10,800; polymorphonuclears, sixty; neutrophiles, thirty-nine; eosinophiles, one.

Röntgen-ray Examination.—(Doctor Imboden.) 1. Diverticulum of the cardiac end of the stomach. 2. Large diverticula (2) in the course of the ascending limb of the duodenum which retain the barium twenty-four hours. 3. Small diverticula in the course of the small intestine, ascending, transverse and descending colon.

Operation.—November 15, 1921. Ante-operative diagnosis, diverticula of the third portion of the duodenum. Post-operative diagnosis, same.

Pathological Findings.—Stomach, gall-bladder, first and second portions of duodenum normal. Two diverticula, one about one and one-half inches, the other about one inch in diameter and about two inches long, were found arising from the posterior surface of the third part of the duodenum. These diverticula extended to the right behind the head of the pancreas, and projected just beyond the right margin of the descending portion. Three diverticula were observed on the convex surface of the jejunum. No further exploration made of the intestinal tract. There was a thick peritoneal band, showing recent inflammation, about four inches in length, extending between the transverse colon and loop of the small intestine.

Operative Procedure.—High middle line incision. Transverse mesocolon opened along the third portion of the duodenum and gurgling could be felt upon palpation, but no other evidence of the diverticula could be made out. The second portion of the duodenum was then freely mobilized. The tips of the two diverticula were then recognized and by gentle traction were drawn beneath the descending portion of the gut, and were found to arise from the ascending portion of the third part. The mouths of the diverticula were separated by about one-half inch of normal gut wall. Openings in the mucous membrane closed by running purse-string of chromic gut. Intestinal wall restored by double layer of chromic gut. Peritoneum overlying duodenum approximated with fine gut. Wound closed without drainage.

Pathological Report.—Specimen consists of two diverticula from the duodenum. They have been sutured along the cut edges and partially distended with fluid, thus forming two irregular ovoid pouches, one measuring 3.8 x 3 x 3.5 cm. The other is 4 x 3.5 x 3 cm. The smaller has the more regular outline, the larger presenting a few coarse lobulations. Both are covered externally with delicate fascial layers. The walls are paper-like in thinness, and in some areas almost transparent. On section they show only faintly the flattened and atrophic remains of the plicæ circulares. The lining is finely granular and appears to consist of mucosa only. Sections of the wall taken from several different areas show that it is composed exclusively of mucosa, being limited on its outer surface by the fibres of the muscularis mucosæ. These muscle fibres are relatively normal, but the remainder of the mucosa is thin and atrophic, the villi are much lower and

more widely separated than normal, and no ducts of Brunner's glands can be found. The epithelium is considerably desquamated from the tops of the villi and the surface covered with a layer of cellular debris and mucus. The tunica propria is hemorrhagic and œdematous, the capillaries contain numerous polymorphonuclear cells, and these are also found in increased numbers in the stroma. The entire mucosa is very much injected and penetrated by large thin-walled sinuses.

Röntgen-ray Examination—Post-operative.—(Doctor LeWald, December 1, 1921.)

Stomach.—The greater curvature is about two inches below the umbilicus. The stomach is dilatated and ptosed. There is a peculiar pouch-like appearance near the cardiac end of the stomach on the lesser curvature close to the region of the opening of the œsophagus, apparently representing diverticulum of the stomach in view of the fact that there are not active signs of ulcer and no ulcer was found in the stomach at the time of the operation.

One hour, twenty minutes. There is still retention in the pouch at the cardiac end of the stomach. There does not appear to be any areas of retention about the duodenum, at this time, which would suggest diverticulum.

Three hours, fifteen minutes. There is some of the meal in the stomach with retention in the pouch at the cardiac end of the stomach as previously described. There are also some rounded areas in the small intestine.

Four hours, forty-five minutes. There is small retention in the stomach with retention in the diverticulum at the cardiac end of the stomach. The coils of the ileum are prominent and are suggestive in places of adhesions. There is some delay in the ileum.

Twenty-three hours. Some of the meal has reached the rectum. There are traces as far back as the cæcum.

Twenty-eight hours. There is still retention in the diverticulum at the cardiac end of the stomach. Also, there is retention just to the right of the interval between the fourth and the fifth L. V., which represents diverticulum, possibly in the ileum. The cæcum is ptosed.

Forty-six hours. There is still retention just to the right of the interval between the fourth and the fifth L. V. Also, is a small rounded shadow of opacity just internal to the lower border of the right sacro-iliac joint. Only faint traces of the meal remain throughout the colon.

Summary.—Diverticulum of the cardiac end of the stomach. Diverticula of the small and large intestine. Colonic stasis. Convalescence uneventful. Discharged from the hospital, December 3, 1921.

Case IV.—*Diverticulum of the Third Portion of the Duodenum. Not confirmed at operation.* (*X-ray Diagnosis.*)—A. LeD., aged thirty-four. Admitted to St. Luke's Hospital, medical service, November 19, 1921. Transferred to surgical service November 25, 1921. Chief complaint, pain in right side.

Present Illness.—For many years attacks of pain and tenderness in the right side. No fever, no vomiting. About four weeks ago present attack became so bad had to remain in bed. Pain is greater when standing. Appetite poor. Always has pain in the back. No jaundice. Past History: General health good except for the attacks of pain.

Physical Examination.—Well-developed and well-nourished woman. Not appearing ill. Temperature, pulse and respiration normal. Otherwise negative, except for slight tenderness at McBurney's point. Meltzer's test positive.

Laboratory Findings.—Negative throughout. Weight, 177 pounds.

Röntgen-ray Findings.—Stomach: The greater curvature of the stomach is on a level with the umbilicus. No filling defect is observed in the stomach or

duodenum. There appears to be some delay in the second portion of the duodenum but this may be due to adhesions.

Fifty-five minutes. The duodenal cap is well filled. The stomach is emptying at a fair rate.

Four hours, fifty-five minutes. There is small retention in the stomach. The head of the column has reached the splenic flexure. No definite delay in the ileum. There is retention in what appears to be the third portion of the duodenum and is probably a diverticulum.

Summary.—Duodenal diverticulum. Seventy-two-hour retention in the appendix. Colonic stasis.

Operation.—November 25, 1921. Pre-operative diagnosis, chronic appendicitis, diverticulum of the duodenum. Post-operative diagnosis, cholelithiasis, chronic appendicitis, diverticulum of the duodenum. Operation, appendectomy, cholecystectomy.

Pathological Findings.—Gall-bladder somewhat contracted, contained numerous fecetted stones. Appendix kinked in proximal portion.

Operative Procedure.—Upper right rectus incision. Gall-bladder and appendix removed. Transverse mesocolon was divided over the third portion of the duodenum and a brief search made for the diverticulum shown in the X-ray. As it was not readily found it was not deemed advisable to prolong the operation further.

Convalescence uneventful. Discharged from hospital.

REFERENCE

[1] Case, J. T.: Diverticula of Small Intestine, Other Than Meckel's Diverticulum. J. A. M. A., vol. lxxv, p. 1463, Nov. 27, 1920.

TUMORS OF THE KIDNEY IN INFANCY AND CHILDHOOD*

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of Boston, Mass.

Four lesions of the kidney occurring in early life will be considered in this paper, namely, new growth, large solitary or multiple renal cysts, polycystic kidney and congenital hydronephrosis. In general all these conditions may be assumed to be developmental in origin, and inflammatory lesions causing tumor, as, for example, pyonephrosis and perinephritic abscess, will not be touched upon.

Formerly lesions of the upper urinary tract in children have not received the attention they deserved, and in many instances have been overlooked entirely, owing to the lack of refinement of diagnosis. Lately, following modern urological procedures adapted to childhood, many positive diagnoses may be made in conditions that were formerly in doubt. For example, I feel that at the present time no pediatrician should be content with a diagnosis of chronic pyelitis until a röntgenogram, cystoscopic examination, ureteral catheterization and pyelogram have proved that there is no underlying cause for the chronic infection—renal stone may be present; or more frequently a congenital stricture located at one of the four points of election along the course of the ureter may exist, or a band or aberrant vessel at the lower pole of the kidney may be the mechanical factor in the persistence of the pyelitis. Within the year two cases of apparently congenital stricture have come under my care in children of ten years. In one, a girl, the history was a long-standing pyelitis, and a stricture just above the bladder was demonstrated by pyelogram, the ureter above the obstruction being greatly dilated, nearly one inch in diameter. Her stricture is being dilated at the present time. The other, a boy, had attacks of pain in the left side of the abdomen and loin, and hæmaturia since he was two years old. A stricture was found at the level of the pelvic brim, with a ureteral stone acting as a ball valve, and a dilated ureter one inch in diameter ran upward to the kidney. In cases of congenital stricture and hydro-ureter, the ureter has every appearance of the small intestine in the thickness of its wall and calibre.

On the degree of stenosis and the position of the stricture will depend to a certain extent the size of the resultant hydro-nephrosis or hydro-ureteronephrosis and the location of the tumor. The ureter normally presents three different points of narrowing: at the uretero-pelvic junction, at the brim of the pelvis, and just above the bladder. These appear toward the end of fetal life, become more marked after birth, and persist through adult life. Stricture may occur at any of these points or in the bladder wall, or a part or the whole of the ureter may be replaced by an impermeable fibrous cord. When obstruction is complete either of two conditions may supervene:

* Read before the Boston Surgical Society, February 6, 1922.

a very marked atrophy of the kidney may occur, or more commonly, an enormous hydronephrosis results.

Anomalies of the ureter are frequently multiple. Strictures may be bilateral, and this should be borne in mind, as nephrectomy should not be undertaken without ascertaining by ureteral catheterization or by palpation, the condition of the other kidney. There may be complete or partial reduplication of the ureters, and these are frequently the seat of stenoses, or they may end blindly, or be abnormally implanted into the bladder. Not infrequently a bilateral hydronephrosis may be caused by a stricture of the posterior urethra in the region of the verumontanum, where, during normal development, fusion of the two segments of the urethra unite and the velum absorbs. If only partial absorption of this veil takes place stricture results.

Bottomley, in 1910, reported fifty-six cases of congenital stricture of the ureter from the literature. In eight the stricture was at the uretero-pelvic junction, and in thirty-six the stricture was at or near the bladder. In seventeen there was an intravesical protrusion of a blind or markedly stenosed ureter. In 1917 Eisendrath added eleven more cases, including four of his own. Since then several other cases have been reported, notably two by Kakels, in 1918. One was an infant of six weeks with an enormous hydronephrosis containing 900 c.c. caused by an impermeable stricture at the uretero-pelvic junction. The relative size of this tumor can be imagined by the comparison with the normal pelvis of the new-born, whose capacity is one to two c.c. His other case was a hydro-uretero-nephrosis in a ten months' old baby, with a congenital stricture just above the bladder. Both cases were operated on by the transperitoneal route, and he emphasizes the advantages of this method of approach, as giving a far better exposure with a very slight risk of peritonitis.

During the past thirteen years we have had on the surgical service of the Children's Hospital seven definite cases of hydronephrosis from congenital stricture of the ureter. Neither of the cases cited above has been included in this group, as a palpable tumor was absent on clinical examination and as an acquired stricture of inflammatory origin could not be absolutely eliminated, though it would seem highly improbable in either case. The age in four instances was less than one and one-half years; in the others two and one-half years, four years, and eleven years, respectively. Sex was of no importance, three occurring in girls and four in boys. Abdominal swelling was noted in all cases and a definite mass was felt in four instances. Twice the malformation proved to be bilateral, three times it was encountered on the right and twice on the left. Stricture at the uretero-pelvic junction with resultant hydronephrosis the size of a grape fruit or larger was found at operation in four cases. In one child, fifteen months of age, the stricture was in the lower portion of the ureter, probably near the bladder, and the opposite kidney was absent. Ureterotomy was done, the fluid evacuated, and the ureter closed. Death occurred on the sixth day, apparently from peritonitis.

Bilateral hydro-uretero-nephrosis occurred in a girl of two and one-half years who had had attacks of cyanosis for a year and a half and who had had X-ray treatments for enlarged thymus. A severe attack of cyanosis began three days before admission to the hospital and she was brought in in a moribund condition from uræmia. The urine was milky in appearance, the specific gravity 1003, and the sediment contained large quantities of pus. At autopsy the bladder was contracted but both ureters and kidney pelves were greatly dilated in consequence of congenital narrowings above the bladder. In congenital strictures of the ureter of marked degree, the ureters are extremely tortuous as well as being dilated. In this case the child had undoubtedly been hovering on the edge of uræmia, induced by back-pressure and thinning of the kidney parenchyma, and the secondary infection and pyelonephritis caused the fatal termination.

As an example of another type of the malformation, a male infant of three weeks was explored for anuria and abdominal swelling since birth. The abdomen contained a large amount of fluid with a urinous odor. The pelvis of one kidney had apparently ruptured from extreme distention. At autopsy the bladder and urethra were normal and the ureters were patent throughout their length. On both sides, however, the probe was halted at the kidney pelvis. The mucous membrane lining was invaginated into the cavity of the pelvis by the tip of the probe, but no opening existed and there was no escape for the urine to the bladder.

From the surgical standpoint, the cases of greatest interest are those in which a large unilateral cystic tumor exists. Stricture at the uretero-pelvic junction has been the most frequent site of the obstruction in this type of congenital malformation in our experience. Abnormal swelling may have been noted since birth or for only a few days. In one girl eleven years old, the story was of intermittent attacks of pain and swelling in the left side of the abdomen for six years. The child was brought in during an acute attack. A pre-operative diagnosis of ovarian cyst was made. At operation a retroperitoneal cystic tumor the size of a football was found, identified as a hydronephrosis from the thinned-out kidney parenchyma discovered on its upper pole, and nephrectomy was done. The ureter appeared impermeable and no fluid could be forced out of the hydronephrotic sac after its extirpation.

Of the seven cases in this series, four were hydronephroses of this type. Nephrectomy was done in two instances with recovery. A two-stage nephrectomy was attempted in two instances on account of the rather poor general condition of the child. In one, a subsequent nephrectomy following the drainage of the pelvis, was followed by a post-operative death. In the second, the parents refused to bring the child back for the secondary operation and he was lost sight of with a urinary sinus persisting. Of the two cases with stricture in the region of the bladder, one with bilateral malformations died of pyelonephritis and uræmia without operation. The other, in which one kidney was absent and the other hydronephrotic and badly damaged,

died following a ureterotomy, probably from peritonitis. In this case I believe it would have been better to drain the pelvis and at a subsequent operation, reimplant the ureter in the bladder. In the light of the autopsy findings in the new-born infant with bilateral absence of openings to either pelvis, it would seem indicated, in any case of double congenital hydronephrosis in which a ureter could be found, to open the ureter, and if a lumen was present and the probe passed to the bladder, to attempt a plastic on the uretero-pelvic outlet, which in the above type of malformation would be very simple.

There is little to be said in regard to symptoms and diagnosis. Abdominal swelling is the most constant finding. A cystic tumor when present should suggest the diagnosis from its position, but many times the hydronephrotic sac, though it may be very large, is not tense and may be so flaccid as to be unidentified as a tumor and be mistaken for a general or localized ascites. Unless infected, the urinary examination will be negative. X-ray examination with inflation of the colon would be suggestive evidence here as with other kidney tumors, as the colon is crowded toward the median line. Eisendrath places all cases of congenital stricture of the ureter in one of four classes.

1. Those remaining unrecognized throughout life and are an accidental finding at post-mortem.

2. Those with abdominal tumor, which may or may not be recognized as of renal origin.

3. Cases in which the symptoms are those of infection, either renal or of an intraperitoneal viscus.

4. The class of cases characterized by disturbances of micturition, either frequency or retention. The urinary symptoms of the latter class are caused by the intravesical protrusion, where the stricture is in the bladder wall. This may be so great as to shut off the opposite ureter or even the internal urethral orifice. Intravesical protrusion is frequent in adults, as shown by Bottomley's statistics of seventeen instances of this type in his fifty-six collected cases. An example of its occurrence in infancy is reported by Wason. A ten months' baby dying of uræmia showed at autopsy double hydro-ureteronephrosis and strictures at the ureter orifices. The bladder was small and the site of each orifice was occupied by a large cystic protrusion. Serial sections cut through the tumor walls and examined microscopically showed minute orifices one-eighth mm. in diameter.

Recognition of this type of obstruction should be accomplished even in infancy. A small nasopharyngoscope can be introduced in the urethra of female infants and the condition determined by direct inspection. In the male urethra, too small for the introduction of this instrument, that is in boys under three or four years of age, if at exploration a dilated ureter is found, a probe should locate the position of the stricture. Where the obstruction is found to be below where the ureter enters the bladder, I believe a suprapubic cystotomy is indicated, the probabilities being that an intravesical

protrusion will be found that can be incised readily. Such a procedure would be far quicker and more simple than a ureteral transplantation where the kidney is not hopelessly damaged.

Nephrectomy is indicated in the large hydronephroses where palpation reveals a normal kidney and ureter on the opposite side. If evidence of stricture is also found on the opposite side, an attempt should be made to establish adequate drainage either by a plastic on the ureter, or by ureteral reimplantation, as there is great probability of an increasing loss of function from back pressure and a subsequent infection in the other kidney as well. The transperitoneal approach is by far the best route to employ in the large congenital hydronephroses of early childhood. The oblique loin incision gives a very inadequate exposure and no data are obtained in regard to the other kidney. There is very slight risk of peritoneal infection, no risk of implantation of disease as in nephrectomy for malignant new growth, and in general children withstand laparotomy very well with the exception of intestinal resection, far better indeed than they do the traumatism incident to removing a large tumor through an inadequate incision.

Polycystic kidney in infancy has little surgical importance save in the differential diagnosis. It has been of rare occurrence on the surgical service, only two cases having been operated on and a third instance of the disease being found in the autopsy records. The latter was a still-born baby with large bilateral tumors, each kidney being filled with great numbers of fine cysts containing watery fluid. Associated lesions were status thymicus, fibrosis of the liver and enlarged spleen. One of the operative cases was an infant of seven weeks with a history of abdominal distention since birth and obstipation. Laparotomy revealed enormous kidney tumors composed of multiple small cysts of varying size nearly filling the abdomen. Death occurred two weeks later. The third case was a boy two years old, who was operated on for left renal stone. Autopsy, following the post-operative death, demonstrated pyonephrosis and infected cysts on the left side and a typical congenital cystic kidney on the right.

Polycystic kidney is a disease encountered at the extremes of life. Many cases have been reported where it was necessary to empty the cysts before delivery of the child was possible, and many others are in new-born infants, as in one of our operative cases. During later childhood and in young adult life cases are rarely encountered, but in the third and fourth decades and later, the majority of cases come to the surgeon for one of three conditions, growth of tumor, hæmaturia or superimposed infection. Uræmic symptoms may be the first sign of disease noted.

Although practically all the kidney tissue may be replaced by cysts and the amount of secreting substance be incredibly small, possessors of such organs may attain adult life without symptoms or knowledge of any kidney disease.

That polycystic disease is always bilateral seems assured from Barnett's

statistics. In his series of 422 collected cases, 291 were described as bilateral, 131 as unilateral. One hundred and four were taken from autopsy reports and without exception were bilateral. In nine of the so-called unilateral cases, nephrectomy had been done. Following these cases up for varying lengths of time, it was found that five of them developed polycystic disease of the remaining kidney. Braasch, in 1916, reporting the cases from the Mayo Clinic, forty-one in number, states that twenty-six were recognized clinically, that tumor was noted in thirty-one cases, but in only eighteen was it described as bilateral before operation. Therefore any diagnosis based simply on the clinical examination is of no value so far as deciding the involvement of one or both kidneys.

Females are more frequently affected, in the proportion of two to one. Other congenital anomalies are often associated, notably harelip, hypospadias and cysts of other organs, especially the liver. Heredity appears to play a definite part in its incidence. Of Barnett's collected cases, fourteen gave a definite hereditary history. The most striking incidence of familial tendency was published by Wobus in 1918.

> The mother was of European peasant extraction, twenty-four years old, at the time of her first pregnancy and was in good health previous to, during, and after her pregnancies. The blood Wassermann was negative. First pregnancy May 8, 1908. Male fetus of seven and one-half months. Abortion was necessary on account of the immensely distended abdomen of the fetus which had to be evacuated before parturition was possible. Ascites was present, the peritoneum was greatly thickened and the abdominal cavity was divided into compartments by adhesions. The kidneys were of enormous size from cystic degeneration, and fused at the lower poles. Second pregnancy January 30, 1909. Well-developed male child. The abdomen had to be drained to permit delivery. The kidney tumors were not so large and they were not fused. Third pregnancy, July 4, 1910. Male full term. Again the abdomen was too large to permit delivery. The kidneys were of smaller size. The parietal peritoneum was thickened, but not elsewhere. Fourth pregnancy November 22, 1911. Female child apparently healthy and normal. Spontaneous delivery. The child has weathered several contagions, but is small for age and not robust. Fifth pregnancy August 10, 1912. Abortion at four months. Fetus destroyed, preventing examination. Sixth pregnancy September 4, 1914. Full-term male child. Abdomen not enlarged, child still-born. Autopsy revealed polycystic kidneys. Seventh pregnancy November 25, 1915. Full-term male child, spontaneous delivery, alive and robust. Wobus remarks on the degree of polycystic degeneration becoming less and less with each successive pregnancy, and also on the evidences of fetal peritonitis, apparently not specific, that likewise decreased.

The pathogenesis of the disease is still a question. Many theories have been advanced, but there are four main views that have received the most

attention. The theory of inflammatory occlusion was advanced by Virchow. Atresia of the tubules was produced by irritation by uric acid and lime salts. Later he modified the theory by the supposition of an intra-uterine papillitis with consequent obliteration of the collecting tubules and cyst formation. The second theory is that of new growth, from the histological resemblance of the cystic degeneration to cyst-adenomata as seen in the ovary. A third view is that it is a developmental malformation, and therefore congenital. Cysts result from arrested development and failure of union between glomeruli and collecting tubules on the one hand, and the straight tubules and the pelvis on the other. The embryology of the kidney supports this view in many particulars. Finally combinations of these theories are held by some observers, to account for the sequence of events in polycystic degeneration that may lead into late adult life. Hagner believes that the disease may originate as the result of embryonic malformation and that subsequent neoplastic formation takes place. The interstitial changes from the compression caused by the cysts themselves, still further tend to augment the size of the cysts.

Epithelial proliferation is commonly seen in polycystic disease, and many observers consider it supports the neoplastic theory. McKinlay cites similar proliferation occurring where an excessive amount of work is thrown on the kidney, as in acute nephritis with degenerative epithelial changes. Also the blood of nephrectomized animals injected into normal animals, will cause numbers of mitotic figures and atypical cell structures in the cells of the tubules. He accounts for the increase in size of the tumor when it occurs after several decades by hyperplastic compensatory change in the renal parenchyma being stimulated when the cysts are in sufficient quantity. The lesion becomes a progressive one and cysts lined entirely or in part with high epithelium, even papillomatous cysts, will result from compensatory hyperplasia of the tubular epithelium.

Little need be said in regard to the diagnosis and treatment of polycystic disease in infants. Bilateral renal tumors, accompanied by ascites in which the nodular masses give the characteristic sensation under the palpating hand of a bunch of grapes, are very suggestive of the condition. The urinary examination is generally negative except when secondary infection has occurred. Hæmaturia is not frequent, unlike the findings in those patients at the other end of the span of life who have passed the intervening period of latency.

Nephrectomy offers little and is not indicated in infancy, as the disease is bilateral, although temporary good results have been reported in the infected cases in adults. The Rovsing operation of puncture of the cysts, and combined with drainage in the infected cases, is the only operation indicated. It will many times tide over a uræmic crisis and the renal function will show improvement. It gives good results in checking hemorrhage, though the effect is not necessarily permanent.

Large solitary or multiple renal cysts are apparently more uncommon than the congenital cystic kidney. Morris in an analysis of 2610 autopsies at the Middlesex Hospital, London, found five cases. Barnett in 10,761 autopsy protocols, from large universities in the United States, encountered the polycystic variety forty-one times. Kretschmer, in 1920, collected ninety-nine cases from the literature and added one more, making a total of 100 cases. It is a disease of adult life, only six instances being reported in children of ten years or younger. The lesion is unilateral, a point of differentiation from polycystic kidney. The right side is slightly more often involved than the left. The frequency of occurrence is greater in females than in males.

There are two main theories of the pathogenesis of large renal cysts, that of congenital malformation, and that of retention cyst following obstruction. It seems probable that the majority are retention cysts. Caulk, in 1913, described the pathology of a kidney containing a large solitary cyst. One papilloma was incrusted with salts and a papillitis had been set up. The cyst lay within that segment of the kidney which was drained by the papilla, and he concluded there was obstruction and consequent formation of a retention cyst. Most of the later observers coincide with this view. The cyst is generally situated at the pole of the kidney, the upper or lower pole being affected indiscriminately.

The symptoms are very indefinite. In only two cases has a correct preoperative diagnosis been made, The diagnosis of a lesion connected with the kidney has been made on numerous occasions, but the true character of the pathology was only demonstrated at operation. The condition has been confused with ovarian cyst, distended gall-bladder, intra-abdominal or mesenteric cyst, and tuberculous peritonitis. Tumor or abdominal fullness, associated with dragging pain in the loin, have been the symptoms most frequently remarked. Hæmaturia is rarely present, the renal function is normal and the urinary examination reveals nothing abnormal in the uncomplicated case. The contents of the cyst is generally of a clear serous character, but it may be urinous, bloody, gelatinous or caseous.

As, in general, the function of the kidney has not been impaired, the treatment should be conservative. The cyst may be enucleated as in Caulk's case, but usually it is too firmly adherent for this procedure. Partial nephrectomy with resection of the cyst is the operation of choice. Nephrectomy may be required on account of the size of the cyst, the largest cyst reported having contained sixteen litres, though the average size has been that of an orange; or bleeding may be so severe following resection as to require the removal of the kidney.

We have had one case of large solitary renal cyst and one of multiple large cysts on the surgical service at the Children's Hospital. A boy of four years was brought to the hospital with acute symptoms of vomiting and abdominal swelling of four days' duration. There were no urinary symptoms. A large mass was palpable in the right side of the abdomen. A diagnosis of probable appendix abscess was made. At operation mul-

tiple large cystic tumors, arising from the lower pole of the right kidney, were found, the total mass being the size of a large grape fruit. The cysts were filled with fluid blood and clots. Nephrectomy was done and the pathological report was "non-malignant cysts, probably arising from a renal anlage." The boy made a good recovery and lived a healthy life for a year and a half, when he died after an acute illness from volvulus around a band of adhesions. At autopsy the left kidney was found to be normal.

The second case was a girl baby of thirteen months. A definite mass and abdominal swelling had been noted for four months. There had been one attack of urinary retention that had lasted twenty-four hours. Otherwise the urinary history was negative. The urinary sediment, however, showed many pus and blood-cells. The child showed evident loss of weight and appeared cachectic. A large tumor was visible and palpable in the right kidney region. It was fairly movable and tense, and a diagnosis of a rapidly growing malignant new growth, undergoing some degenerative softening, was made. An exploratory operation was undertaken and a large solitary cyst arising from the lower pole, the size of a small grape-fruit, was found. Before the cyst was freed, the kidney was not in view and I believed I was dealing with a large congenital hydronephrosis, a condition I had encountered twice before, and on this supposition I did a nephrectomy, the left kidney being normal to palpation. The cyst was filled with serous fluid, and with the exception of the lower pole, from which the cyst sprung, the kidney was normal. The child made an uninterrupted recovery and when last heard from, eight months after operation, was in good health and developing normally. In spite of the presence of blood and pus in the urinary sediment, I feel that, had I known what I do now about solitary cysts of the kidney, I would have done a partial nephrectomy and saved two-thirds of the renal tissue.

In considering the malignant tumors of the kidney, I have included the neuroblastomata of the adrenal, as the location of the primary tumor is in the kidney region, and they can only be differentiated clinically by certain characteristics of the metastases. The kidney is a favorite site for malignancy in infancy and unfortunately its invasion is so silent that it is only the rare exception that comes to the surgeon in any but the most advanced stage.

The frequency and importance of the neurocytoma or neuroblastoma in the tumors of early infancy has only lately been recognized. In 1903 Kretz suggested the origin of certain lympho-sarcomatous tumors of the liver from the formative cells of the sympathetic nervous system, and in 1910 Wright described the histological characteristics and emphasized the importance of this class of new growth. He considers the essential cells of the tumor more or less undifferentiated nerve-cells, or neuroblasts, from the presence of delicate fibrils, the morphology of the cells, and the arrangement in bundles, similar to those found at certain periods in the development of the sympathetic nervous system and in the anlage of the adrenal.

Clinically the neuroblastoma presents two types. It may occur as a very rapidly metastasizing and diffusely disseminated malignant process in which the primary tumor in the adrenal may be readily overlooked on account of its small size and relatively slow rate of growth. This type may present bilateral tumors of the adrenal. Such a case in a child of two months presented multiple tumors of the buttock, liver and forehead, the tumor in the latter location being the size of a small orange, while the primary tumor, though suspected, could not be palpated and was only demonstrated at autopsy, when masses were found in each adrenal, the larger being the size of a walnut. The other clinical type is where the tumor grows to large size without evidence of metastases and which cannot be differentiated on gross examination of the specimen from embryoma and only the histologic examination will disclose its character.

The other type of malignant disease in the kidney region has been known clinically as sarcoma, but histologically these tumors present nearly every type of cell that one cares to look for, and for this reason the pathological classification has been greatly involved in the past. Tumors that present the same clinical characteristics have been called spindle-cell sarcoma, hypernephroma and even carcinoma, depending on the preponderance of connective tissue, epithelial cells or various other elements in any given section. Smooth and striated muscle, epithelium in cylinders and even rudimentary tubules or glomeruli, cartilage and connective tissue may be present. It is probable that they all arise from developmental remains, and different types of tumors are simply the expression of different degrees of differentiation of the same embryological new growths. For this reason the comprehensive term embryoma, synonymous with mixed tumor, has been applied to these malignant tumors of early childhood.

It is not generally recognized how common malignant disease of the kidney is in early life. In 1914 Loughnane obtained, from the Registrar General's Return of Death, the fatalities from cancer of the kidney and suprarenal capsule in children under fifteen years in England, for the eleven years, 1901–1911, inclusive. There were 430 cases in children under five years, while only 127 occurred between the ages of five and fifteen years. In children under twelve years malignant tumor of the kidney or adrenal was encountered twenty-seven times on the Surgical Service of the Children's Hospital or among my personal records, during the last twelve years. In twenty-three cases a pathological diagnosis was obtained and in the remaining four cases the condition was established by exploration, although no pathological specimen was obtained. No suspected cases that have not been demonstrated by these methods have been included.

In recording malignant tumors of all ages, Albarran and Imbert found that males were attacked more frequently than females in the ratio of three to one. Loughnane found children to be affected irrespective of sex. In our own series of twenty-seven cases, boys were more susceptible in the

proportion of four to three. In striking contrast to the adult, hæmaturia is rare, and there are no early symptoms. Hæmaturia occurred only twice in our cases, and microscopical evidence from the sediment was obtained only seven times. Listlessness, malaise, loss of weight, diarrhœa or constipation, and sometimes vomiting is noted by the parents, but almost invariably the symptom that brings the child to the doctor is abdominal distention or the actual discovery of the tumor by the parents. In other words, there are no early symptoms. Pain or abdominal discomfort was present in fifty per cent. of the cases; usually it is dull and dragging and rarely sufficient to excite suspicion. A slight elevation of temperature from one to three degrees is frequent. In nearly two-thirds of the cases, a month, and frequently much more, elapsed after the onset of symptoms which were manifestations of advanced disease, before the child was admitted to the surgical service. The children with one exception were all under five years of age, the average age of those with embryoma being three and one-half years and those with neuroblastoma being one and three-fourth years. Twenty-three cases were operated on and four cases came to autopsy without surgical interference. Nephrectomy in fourteen cases gave an operative mortality of thirty-five per cent. Nine cases of simple exploration were followed by forty-four per cent. mortality.

Of the nine cases surviving nephrectomy, with one exception all showed rapid recurrence, death occurring in from four months to one and one-half years. It is interesting to note that the single exception differed in no way either clinically or pathologically from the other cases of embryoma. The tumor was of large size and no post-operative radiation or serum were given. The child is alive and well at the present time three and one-half years following nephrectomy.

The average size of the tumor removed at operation was that of a grapefruit. Once the signs of disease are manifest, the course is very rapidly fatal and the high mortality following both nephrectomy and simple exploration is accounted for by the extreme degree of cachexia in which the patients come to operation.

Of the twenty-seven cases, no pathological report was obtained in four, five were neuroblastomata, one was small spindle-cell sarcoma and the rest were embryomata. The neuroblastoma metastasizes much more freely than the embryoma, the flat bones, liver, retroperitoneal glands and lungs being frequently involved. On the other hand, embryoma tends to recur locally, and invades by extension to the retroperitoneal glands and the peritoneum, and only rarely metastasizes to the liver and lungs. This being the case, it would seem that in the moderately early case nephrectomy with dissection of the retroperitoneal gland bearing tissue, followed by intensive X-ray treatments, should give a fair percentage of cures. As a post-operative measure, we have given X-ray treatments in two cases—Coley's serum in one case and radium in one—and have seen no beneficial effect in any instance. Loughnane's

statistics are far better than ours. He reports thirteen personal nephrectomies with one death, seven and seven-tenths per cent., and seven exploratories with two deaths, twenty-eight per cent. mortality. His late results of nephrectomies are: Result unknown in three cases, four have survived three years or more, two alive and healthy, two years and six months after operation, two died from recurrence within six months and one died of phthisis three months after operation. He believes recurrence is rare after four or five years. Of the thirty-five nephrectomies he collected from the London hospitals, there was over eighty per cent. of recurrences, seventy per cent. occurring within the year.

Stress should be laid on the necessity of an early diagnosis in the malignant tumors of the kidney in infancy. The symptoms are so ill-defined that in all cases of obscure abdominal disturbance, unaccountable malaise, or abdominal fullness, even if no urinary symptoms are present, the kidney regions should be palpated. If a tumor is felt, operation should be advised without delay. If resistance is noted, even in the absence of tumor, an X-ray with air inflation of the colon should be obtained and an ether examination made. The importance of the relaxation obtained by a general anæsthetic in the palpation of suspected deep-seated tumors of infancy cannot be overestimated.

In conclusion, I want to emphasize the frequency of malignant tumor of the kidney region in infancy, the insidiousness of its onset, and the necessity of its early recognition, as the tendency to recurrence is so great that only by its early surgical removal can we hope for a cure.

INTRAPERITONEAL RUPTURE OF THE BLADDER*

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In looking up the literature of rupture of the urinary bladder recently it was found not as abundant as expected. This accounts for the usual brief discussion of the subject in our text-books. In my first operative experience more than ten years ago in the Philadelphia General Hospital, I was surprised by the difficulty experienced in closing the rent in the bladder. Further experience came slowly, and when an effort was made recently to find the record of this case it proved unsuccessful. Memory must therefore be relied on for the important facts connected with it. The surprise experienced in this case was to be explained not only by my individual lack of experience, but by a general inexperience which explains the scarcity of important papers on the subject. With regard to the mortality which still remains high, few probably appreciate that so high an authority as Rivington in his Hunterian Lecture (*Med. Press and Circular*, vol. ii, 1882, p. 434), after a very critical analysis of all the reported cases, could say that he doubted "whether a single unequivocal recovery after intraperitoneal rupture of the bladder has occurred." He says further, "I do not in this age of antiseptics absolutely despair of a time arriving when it can no longer be said."

The essential facts of the above case were as follows: A middle-aged foreigner, not familiar with our language, was admitted with an acute abdomen, and it was not until the abdomen was opened on the same day that an intraperitoneal rupture of the bladder was discovered. The intestines were considerably distended and the exposure of the posterior wall of the bladder was very difficult and unsatisfactory. It contained a rather extensive and irregular rupture. With the poor exposure and the difficulty of seeing and controlling the irregular margins, the placing of the suture was distinctly difficult and the closure imperfect. The particular causes of the difficulty were deficient laxity in the bladder wall and my previous failure to become acquainted with the anatomical features associated. Too much bladder wall was used up in approximating the irregular margins of the rent, so that this first line of sutures could not afterward be turned in by a Lembert suture.

Walsham (*Medico-Chirurg. Trans.*, 1888, lxxi, p. 149), in reporting a case operated on, said "some difficulty was experienced in obtaining a good view of the part (bladder rent) in consequence of the contraction of the recti muscles, the bulging of the intestines into the wound, and the contracted state of the bladder, which lay deeply placed in the pelvis behind the pubis." He employed to advantage a hooking upward of the bladder by an assistant while the rent was being sutured. His statistics appearing only six years

* Read before the Philadelphia Academy of Surgery, January 9, 1922.

after Rivington's paper showed an encouraging improvement in the results of treatment. Of his seventeen collected cases in which abdominal section was done, in three the rupture was extraperitoneal, and of these two died and one recovered. Of the fourteen intraperitoneal ruptures, the rent was sutured in eleven and not sutured in three. Of the eleven sutured cases five recovered and six died. Of the five which recovered in only one was a drainage tube employed. In three a catheter was retained in the bladder, though in one of these it was removed two hours afterwards. Of the three cases in which the rent was not sutured, a drainage tube was inserted in all. One recovered and two died. Walsham thought the presence of a catheter was attended by the risk of cystitis and subsequently septic changes in the bladder wound. In reporting a second case in the same journal (1895, lxxviii, p. 273), he again emphasizes the difficulty in closing the rent and the particular advantages of first introducing the upper sutures, tying and using them as tractors, and of using a Smith's rectangular cleft-palate needle for closing the lowest one-fifth of an inch of the rent which could not be reached and secured by the Hagedorn needle employed for the closure of the rest of it. He says that it is from failure to close efficiently the deepest parts of the rent that several fatal results have ensued. Leakage of the bladder from inefficient suture or the giving way of a stitch, occurred in no less than four of the cases collected from the literature and in two was the direct cause of peritonitis and a fatal result.

Jones (ANNALS OF SURGERY, xxxvii, 1903, p. 215) said that the difficulty experienced by Walsham can be obviated largely by putting the patient in the Trendelenburg position, by leaving the ends of each successive suture long and beginning to suture the upper end of the wound. By this means the wound is pulled up within easy reach and each suture below can be placed without difficulty. Many surgeons, however, would probably prefer to avoid thus favoring the extravasated blood and urine passing further upward among the coils of intestine.

The reported mortality of intraperitoneal rupture still remains high. Jones collected fifty-four cases from the literature, of which twenty-six died and twenty-eight recovered (mortality forty-eight per cent). In thirty-two cases published previous to 1893 there were but twelve recoveries (mortality sixty-three and five-tenths per cent.), while in twenty-two cases reported between 1892 and 1903 there were fifteen recoveries (mortality twenty-seven and five-tenths per cent.) The cause of death generally was peritonitis, shock or hemorrhage. Dambrin and Papin (*Ann. d. Mal. Org. Genito-urin.*, Par., 1904, xxii, pp. 641, 721 and 801) say that when the rent is located very low down in the cul-de-sac of Douglas the interference of the loops of intestine makes the closure difficult. Of seventy-eight collected cases of intraperitoneal rupture they found that forty-four recovered and thirty-four died (mortality forty-three and five-tenths per cent.). Of the thirty-four cases operated on between 1895 and 1904, twenty-seven recovered and seven died (mortality twenty and five-tenths per cent.).

My second case was of the same type as my first, but although the obstacles of the first were overcome by care, and a tight closure obtained, this patient also died.

A Russian workman, fifty-six years old, was admitted to the Philadelphia General Hospital, September 30, 1917, with severe pain in the abdomen, high up, and inability to urinate. He lay on his back with his legs drawn up and he was in great pain which was distributed over the whole abdomen and associated with marked tenderness and board-like rigidity. He had been drinking heavily when two days before admission he fell and was afterward unable to urinate. On admission a catheter was passed and about 500 c.c. of cloudy urine was withdrawn. A cystoscopic examination showed no urine escaping from either ureter. On the anterior surface of the bladder was noted what appeared to be an old blood clot. Rupture of the bladder was diagnosed and the patient was soon afterwards operated on through a midline incision below the umbilicus. The peritoneum was much thickened and the intestines distended. There was a ragged transverse opening in the posterior wall of the bladder about two inches long. With considerable difficulty the mucous and muscular coats were approximated by a continuous catgut suture first and then this was turned inward by a similar Lembert suture. A catheter was left in the bladder through the urethra. Fluid injected through the catheter into the bladder did not show leakage through the line of sutures closing the rent. A cigarette drain was placed in the pelvis and brought out of the lower angle of the incision, which was closed around it. On his return to the ward the patient was placed in the Fowler position and Murphy enteroclysis begun. Although at this stage he seemed to be doing well he died a few hours later.

The cause of the high mortality has been frequently discussed, but I have seen no attempt to explain the difficulty in closing the lower part of a rent in the posterior or peritoneal wall. The explanation is anatomical and should be better appreciated so that one may take advantage of the opportunities to avoid the difficulties. Normally, there is little laxity in the bladder wall anywhere. It is adherent to the surrounding structures everywhere, except on its posterior peritoneal surface, very firmly to the prostate and urethra in the male and to the urethra and vagina in the female, more loosely to the pelvic wall in both sexes, to the rectum and seminal vesicles in the male and to the uterine cervix in the female. The laxity of the posterior or peritoneal wall varies much with the capacity of the bladder, from that of the frequently overdistended and atrophied bladder to that of the normal bladder in which there is very little laxity.

When my first case developed signs of peritonitis soon after operation it was concluded that this resulted from leakage of urine into the peritoneal cavity through the poorly sutured rent and that the condition was then hopeless. The following case gave me my first demonstration that free leakage of urine into the peritoneal cavity did not make a fatal termination inevitable.

The patient was a foreman machinist, forty-five years old, with a powerful physique but a sallow complexion. He had been a heavy drinker of alcohol for years but his urine was normal. He was operated on at St. Agnes' Hospital for a direct inguinal hernia on the left side about the size of an orange on September

10, 1918. A fatty mass was exposed at about the site of the external ring and the hernia, and this was suspected of containing a part of the bladder wall. The bladder and the sac to the exterior of which the bladder is adherent on the inner side were both adherent to the margins of the hernial ring, but the presence of the bladder had not yet been demonstrated. In order to avoid opening the possible protrusion of the bladder a careful search was made for the sac in the fatty mass along its outer side or as far away as possible from the bladder. After a careful dissection a very small sac was opened and a finger passed through it into the peritoneal cavity the finger being grasped by a tight fibrous ring. The fat was then stripped from the small sac to the ring where the sac was tied off by a catgut ligature and cut away. The fatty mass still protruded and was adherent to the fibrous margins of the hernial ring. In order to return the mass into the abdominal cavity a careful search was made to separate it from the margins of the ring without opening a possible bladder protrusion. During these manœuvres a small area of mucous membrane surface appeared in the mass and this could only mean that the bladder had been opened. However, no urine had been detected and it was felt that the peritoneal cavity had been closed off by the ligature and thus protected. It was decided that it would be safer not to attempt further freeing of the protruding bladder from the margins of the hernial ring. The finger was passed through the mucous opening with some resistance and it was concluded that the finger was in the bladder. It was not until the removal of the finger that urine was detected in the wound. Its absence until this time is explained by the tight closure of the fibromuscular hernial ring. The bladder opening was closed by a catgut ligature and the skin wound closed by silkworm gut, a small gauze drain being introduced to the site of the ligatures. The wound was dressed and the patient put back to bed. The after course was interesting and not a little disturbing.

On September 11th, it was noted that the patient had done poorly since the operation, and it seemed evident that the urine was escaping into the peritoneal cavity. The abdomen was rigid and considerably distended and no peristalsis could be heard. There was persistent vomiting and the face had an anxious expression. I concluded that a fatal termination was probably inevitable but took him to the operating room and under nitrous oxide anæsthesia opened the wound and forced a finger into the peritoneal cavity, when a considerable quantity of urine escaped from the abdomen. A large rubber drainage tube was carried by a long forceps to the bottom of the pelvis and brought out the lower angle of the wound which was sutured around it and covered by a gauze dressing. The patient was taken back to bed, placed in the extreme Fowler position and given Murphy enteroclysis. Within twenty-four hours after the drainage tube had been introduced a distinct change for the better had become evident. This improvement continued without interruption. After the introduction of the drainage tube the urine escaped entirely from the wound, none from the urethra.

Under date of September 25th, it was noted that the gradual improvement continued. A small piece of sloughing tissue appeared in the wound and when it was pulled upon, it proved to be a large piece, in all probability a portion of sloughing omentum. A considerable quantity of pus mixed with urine also escaped. On October 6th, the following note was made: Until last night the urine escaped almost entirely from the wound, when an attempt was made to close the sinus temporarily by means of a collodion dressing. It was partially successful, but after this urine coming through the wound was very much diminished and soon almost all was escaping by the urethra. He left the hospital October 11th and returned to work a month afterward. He has since enjoyed better health

than for some time before the operation, but the hernia has recurred to about the same size and its retention by a truss is still troublesome.

At the Northeastern Hospital, on January 21, 1919, on a woman thirty-nine years old, I did a double salpingo-oöphorectomy for a chronic purulent salpingitis of about fifteen years duration. Many old and well organized adhesions had to be broken up, those between the sigmoid flexure and urinary bladder being very dense and strong. The danger of opening the bowel or bladder was fully recognized and due care taken but an opening not quite large enough to admit the end of the finger was made into the bladder. Notwithstanding the small size of the opening the edges could not be approximated by sutures because of the lack of laxity in the bladder wall made abnormally rigid by the old inflammatory process. It would have been necessary to mobilize it by separating the lateral walls of the bladder from the adjacent pelvic walls, but in the presence of the infection this was considered inadvisable. Because of the success of free suprapubic drainage in the hernia case just related, it was concluded to afford such drainage without any further attempt to close the bladder rent. With a large drainage tube from the bottom of the pelvis coming out of the lower angle of the abdominal incision and the patient in the extreme Fowler position with Murphy enteroclysis the after course of the case did not seem to be at all threatening. When she left the hospital seven weeks after the operation the urine was still discharging through the suprapubic drainage sinus and this did not cease entirely until about ten months after the operation. She has never complained of any abdominal trouble since leaving the hospital, is now very strong and weighs 239 pounds.

In the following case reported by Flower (*Brit. Med. Journ.*, August 2, 1914, p. 398) free abdominal drainage through the midline incision without closure of the bladder rupture tided the patient over the dangerous peritonitis stage until in a later operation the bladder opening was sutured.

A man, nearly seventy years old, an alcoholic with arteriosclerosis and emphysema, weighing 265 pounds, tripped and fell on his face about nine o'clock one evening. Early on the following morning he was seized with intense abdominal pain and an urgent desire to urinate but repeated attempts to void were ineffectual. At five A.M. on this second day he was catheterized by his physician and a blood-stained urine evacuated. He was transferred in a sitting position to a hospital and taken to the operating room at nine P.M., twenty-four hours after the accident. Rupture of the bladder was diagnosed, but in view of the great weight and bad condition of the patient Flower concluded to merely drain the abdomen thoroughly to relieve the fast spreading peritonitis and tie in a catheter rather than delay by trying to find and suture the collapsed bladder. After opening the abdomen two large tubes were introduced one to the left flank whither the urine was trickling and one down to the bladder. For some hours both tubes drained well, but latterly all the urine came from the pelvic one and next to nothing from the catheter. The patient's general condition improved so much that it was decided to look for the bladder and repair the damage on the fourth day after the first operation. This was accomplished with much difficulty. After much sloughing of skin and fat around the abdominal drainage tubes, abscess of the scrotum and much œdema of the whole scrotum and penis, the patient was discharged six and a half weeks after the occurrence of the rupture.

CONCLUSIONS

1. Intraperitoneal rupture of the urinary bladder is infrequent and its literature scanty. Its mortality is still high but has been much improved in the past forty years, before which recovery was almost unknown.

2. The absence in the posterior or peritoneal wall of the normal bladder of a sufficient laxity for easy and secure suturing of a rent in it is entitled to more consideration than it has received.

3. Free escape of urine into the peritoneal cavity through an intraperitoneal rupture, closed poorly by suture or not at all, will not necessarily lead to a fatal peritonitis. Free suprapubic drainage with the Murphy enteroclysis and the Fowler position may lead to recovery.

THE BONY FEATURES OF POSTERIOR CONGENITAL DISLOCATION OF THE SHOULDER

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Introduction.—"It is my belief that there is no such condition as congenital posterior dislocation of the shoulder." This is the opening sentence of A. S. Taylor's recent vigorous paper upon this much debated subject.[1] Taylor voices not merely his own views, but those also of many surgeons who have made a careful clinical search for the condition rather loosely described in my title. The English language is not peculiar in its possibility of shrouding a definite idea in the most misty and obscure of terms. Whereas, at one time the actual clinical condition was no doubt perfectly well understood, its definition in such words has intensified the later misunderstanding especially since we have become much more exacting in the precision with which terms should be employed. My defense for using this title is the simple fact that it conveys efficiently an idea of the subject which I desire to discuss.

Stimson in his work on fractures and dislocations[2] gives an excellent general review of the literature dealing with all varieties of conditions which have been or may be considered under the head of congenital dislocation, and it is therefore quite unnecessary to consider this aspect of the problem afresh. We may group them as true congenital dislocations, posterior subluxations of infancy, dislocations due to paralysis, pathological dislocations and dislocations by deformity. Of the last mentioned, Stimson says:

"Most of the specimens of dislocations by deformity are open to the doubt whether they may not actually be nearthroses following traumatic dislocations, and this is especially true of those in which dislocation is forward. Gurlt[3] describes seventeen specimens concerning which this doubt exists, and I think he might well have added to them several of those which he described as examples of chronic inflammation." *

It is not my intention to enter the debate concerning congenital dislocation of the shoulder in general nor in particular to champion either the advocates of so-called congenital dislocation (posterior subluxations of infancy and dislocations due to paralysis) supposed to result from nerve lesions in the brachial plexus (see 1) or the supporters of the theory that birth palsy

* Gurlt was able to find in the literature only one case of undoubted bilateral subacromial "congenital" dislocation, namely that published by R. W. Smith in the Dublin Journ. Med. Sci. and afterwards in his Treatise upon Fractures in the Vicinity of Joints. Gurlt's charmingly clear description of this single case shows that its features were precisely the same as those of our No. 635 (Fig. 2) except that in our No. 635 the scapulæ were of normal size, the muscular attachments typical for age 32, and there was no marked anomaly of the humeral heads (see 3).

is a sequela of "congenital dislocation" (see 4). I desire to focus attention upon certain facts observed in the study of 730 bodies in the dissecting room. These are indisputable and can be readily confirmed as the entire series of complete skeletons of these bodies is preserved along with all necessary data.

It is of course beyond question that one does not see cases of "congenital dislocation" just after birth, and indeed one is fortunate to find them within a few weeks of birth. Even then the radiogram of the area yields but little information since ossification of the glenoid region is still quite imperfect. Stereoscopic radiograms alone could give even the faintest indication of the real condition of the parts. The radiograms published as illustrations by various authors are hopelessly obscure for study of detail and hence they may be passed over without further comment. The fact that one does not meet with cases presenting symptoms immediately after birth naturally cannot be used as evidence that some disability was not already present at birth. Nor, I think, should one confine his attention to the upper end of the humerus; it is my endeavor to show that the abnormal condition may not affect the humerus at all but only the scapula. Taylor [1] quotes Truesdale as denying that there was ever "epiphysial separation of the upper humerus associated with Erb's palsy in his experience." This is a case in point; we should not expect to find violent injuries of this type, and the mere statement of them indicates deviation of attention away from the scapula and towards the humerus.

Now the condition to which I wish to draw attention is not very uncommon and, indeed, in its less marked stages is of rather frequent occurrence. It is an actual deformity of the glenoid region of the scapula in which the dorsal part of the neck never adequately develops, with the result that the glenoid surface looks more backward than usual and the normal head of the humerus bears an abnormal relation to the shoulder contour. The humerus is in no sense of the word dislocated and therefore this is not a dislocation which can be reduced. There are concomitant anomalies in acromion and perhaps in the coracoid which have been erroneously interpreted by previous writers upon the subject. Indeed the features presented by such cases are so definite, whatever the degree in which the anomaly is evinced, that a short description of the bony peculiarities seems to me worthy of record. I have therefore made a careful study of all our material, comprising 730 skeletons, after having previously examined each body upon its admission to the department.

Characters of Chronic Pathological Dislocation.—The survey shows that there is a wide and essential difference in the appearance of the bones in the so-called congenital dislocation from that of the bones in pathological dislocation acquired during post-natal life and never reduced. Briefly the characters of the pathological dislocation are those resulting from a malposition of the normal humeral head in relation to the normal glenoid cavity, whereas the features of congenital dislocation are those of malposition of a practically normal humeral head resulting solely from an improperly placed glenoid fossa and anomalous acromion.

To introduce the subject and make the essential difference clear we shall first consider the characteristics of unreduced pathological dislocation. Figure 1 represents such a dislocation of uncertain duration. All such specimens in our collection are examples of the subcoracoid type. In the total of 730 complete human skeletons we find three examples of unreduced subcoracoid dislocation but none of the subacromial type. This is quite important: in the usual museum collections the number of specimens of any given lesion affords no criterion of the real frequency, since there is no evidence of how large a material the examples represent. In order to obtain dependable information upon such points as this we have preserved the entire skeletons of all cadavera which have passed through the dissecting room during the last seven years. Upon the basis of this collection we can state that in the stratum of society which ultimately drifts into the Anatomical Department, there are of subcoracoid dislocation three cases among 489 white males (six-tenths per cent.), no cases among 143 negro males, no cases among sixty-six white females, and no cases among thirty-two negro females. But in the combined total of 730 individuals there is not one instance of pathological subacromial dislocation.

We shall briefly examine these cases as a preliminary to the discussion of congenital dislocation.

The three specimens are listed as follows: Skeleton 274, male, white, age forty-five; left shoulder dislocation. Skeleton 284, male, white, age seventy; left shoulder dislocation. Skeleton 363, male, white, age sixty-four; right shoulder dislocation.

The age at which dislocation first occurred is unknown in any of the cases, but this is quite unimportant. The common type to which all conform is well shown in Fig. 1. The glenoid surface is normal in contour in most of its outline, and in position relative to the body of the scapula and the scapular neck upon which it is supported. The humeral head is entirely normal in all respects except as below. Signs of pathological lesion are seen upon the ventral aspect of the neck of the scapula and upon the dorsal surface of the upper end of the humerus adjacent to the greater tuberosity. It is plain that in these two areas a nearthrosis has been formed consequent to the dislocation of the humeral head from the glenoid cavity. The glenoid margin is slightly encroached upon by the new joint surface, the outline of which is marked on the scapular neck by osteophytic outgrowth. The nearthritic surface is slightly polished in places. The glenoid surface shows some roughening and alteration of texture subsequent to loss of contact with the humeral head. Such alteration of texture is not evidenced in the humeral head itself. There is however a flattened area between the greater tuberosity and the head of the humerus: this is the nearthritic surface. In this case, No. 363, as in No. 284, the humerus shows less effect of the chronic disarticulation than does the scapula. In No. 274 the situation is reversed.

Summing up then the probable course of events in pathological subcoracoid dislocation, we may state that there is at first no malformation of either

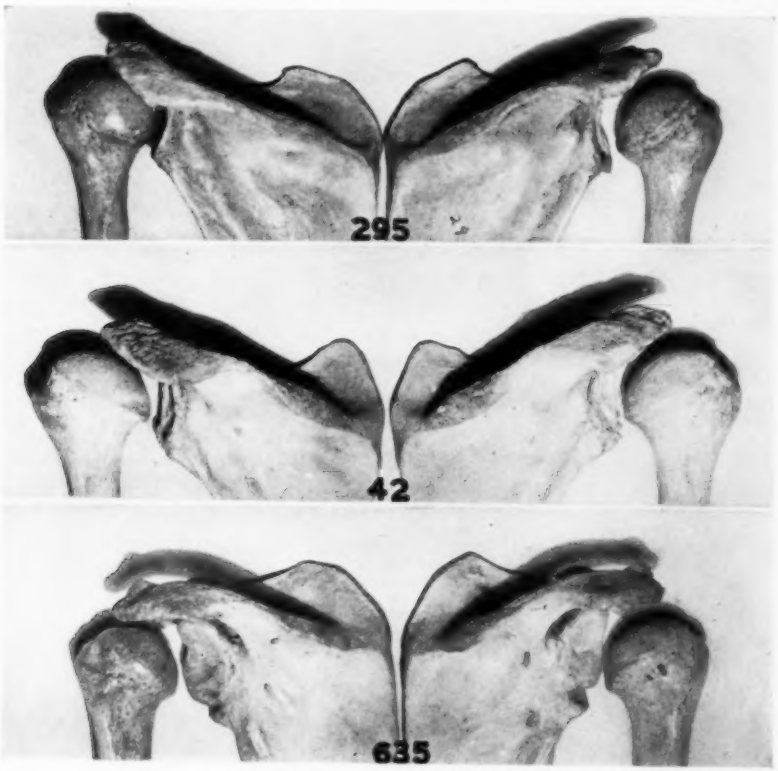
FIG. 2.—Stereoscopic dorsal view of right scapula and humeral head from male white skeleton No. 635, W.R.U., age 32 years. This is a typical case of bilateral congenital subacromial dislocation of the shoulder. Note the practically normal condition of the humeral head, the almost normal character of the glenoid surface and outline, and the defective development of the dorsal portion of the scapular neck upon which the glenoid surface is mounted. Note also the anomalous curve of the acromion.

FIG. 1.—Stereoscopic view of right scapula and humeral head in the case of male white skeleton No. 363 W.R.U., age 64 years. Note the nearthrosis developed between the ventral surface of the scapular neck and the dorsum of the humeral head adjacent to the greater tuberosity. This is in consequence of chronic dislocation. Note the precise direction in which the glenoid surface (normal except for the nearthrosis) faces and contrast it with the condition shown in Figs. 2, 3, 4.

FIG. 4.—Stereoscopic dorsal view of right scapula and humeral head from male white skeleton No. 295, W. R. U., age 41 years. There is slight deformity of the right scapular neck with consequent dorsal rotation of the glenoid surface droop of the acromion. The normal left side may be used as a contrast.

FIG. 3.—Stereoscopic dorsal view of right scapula and humeral head from male white skeleton No. 42, W. R. U., age 38-40 years. The condition of the scapular neck noted in FIG. 2 is present to a mild extent on the right side of this specimen and to a slighter degree on the left side. Note the consequent backward rotation of the glenoid surface. Note also the slight droop of both acromial processes.

FIG. 5.—Dorsal view of scapulæ and humeral heads of skeletons 235, 42 and 295 to show droop of the acromion as evidenced by its shadow. For full description see legends of Figs. 2, 3, 4.



humerus or scapula, but that the longer the dislocation remains unreduced, both humeral head and scapula become more greatly deformed. The dorsal aspect of the humeral head becomes flattened and a new articular surface develops. Likewise a new articular surface is formed on the ventral aspect of the scapula adjacent to the glenoid fossa, the ventral margin of which becomes excavated. Around the newly formed articular surface there develops an osteophytic ring which gives a secure articulation for the humeral head, maintaining for it a good working socket. Meanwhile the articular surface of the glenoid fossa undergoes changes consequent upon loss of contact with the humeral head.

Characters of "Congenital" Subacromial Dislocation.—In "congenital" dislocation, as represented in our collection, we face an entirely different condition. Here the humeral head is not deformed and does not leave the glenoid fossa. The faulty development relates entirely to the scapula.

The first example (Fig. 2) represents the type in skeleton No. 635, W. R. U., male, white, age thirty-two years. This is a case of bilateral congenital dislocation. The humeral heads are normal. They appear very slightly flattened but this flattening is not beyond the normal range. The scapulæ also are normal except for the glenoid fossæ and the acromial processes. Instead of being almost at right angles to the blade of the bone the glenoid fossa is rotated so that it lies obliquely on the dorsum of the blade. There is no anomaly of the glenoid surface itself and no arthritic change. One might say that the condition has been brought about by failure to develop of the dorsal part of the neck supporting the glenoid surface so that the articular area has been swung backwards. This is, of course, a crude method of stating the case and is not to be taken as a hypothesis upon the actual method of development. It is merely utilized as a convenient mode of expressing the condition. Coincident with the glenoid deformity there is an overhang of the acromion which droops downward over the humeral head. The outer end of the clavicle does not drop, however, and the coracoid is normal: hence the acromion is more tilted than usual and has its dorsal edge on a much lower plane than its ventral margin. Indeed the articular surface for the clavicle is distinctly drawn out and tilted upward as the photograph clearly shows. The precise amount of droop of the acromion is difficult to describe, but is clearly seen in the stereoscopic picture (Fig. 2). Again in the flat photograph (Fig. 5) curvature of the shadow, when compared with that in the accompanying specimens, shows fairly accurately the amount of convexity. I myself as usual examined this cadaver when it first came into the department, made the routine anthropometric measurements and observations, but failed altogether to note any anomaly of the shoulder marked enough to be obvious after death. The clinical history of the case at City Hospital presents no evidence upon the point.

The bilateral nature of the deformity in No. 635, just described, precludes the possibility of its being considered other than congenital. From published records such as those of Thomas [4] to which reference

has been made, it would seem that even bilateral congenital dislocation of the shoulder may occur without causing any marked disability, or, at least, any disability so pronounced as to interfere with the carrying on of the patient's daily work.

The occurrence of Case No. 635 gave a clue to the appearance already noted in two other skeletons the features of which must now be discussed.

Skeleton No. 42, male, white, age thirty-eight to forty years (Fig. 3), represents a lower grade of the same deformity. It is also bilateral, but the deformity upon the right side is greater than that upon the left. Again the humeral heads are normal. The glenoid surface is normal and is only slightly lipped in accordance with the age. Upon the right side failure of the hinder part of the neck to develop fully has resulted in a rotation backward of the glenoid surface. Accompanying this is a small droop of the acromion which is well shown by the character of the shadow (Fig. 5), but which is not sufficient to result in an upward projection of the articular surface for the clavicle.

The left side shows the same condition in still slighter grade. The glenoid surface has a backward tilt only just perceptible and the shadow of the acromion is barely curved.

Skeleton, No. 295, male, white, age forty-one years (Fig. 4), illustrates a condition which would probably have passed unnoticed but for the existence of the two skeletons just described. The left shoulder is normal. One should observe the degree to which the glenoid surface shows (Fig. 4) and the extremely straight shadow of spine and acromion (Fig. 5). On the right side there is very mild rotation of the glenoid surface and a slight curvature of the acromion as evidenced by its shadow.

Frequency of the Condition.—From the observations recorded in the above three cases we note that congenital dislocation of the shoulder, of the sub-acromial type, is the result of an extreme mal-development of the scapula whereby the glenoid surface is rotated backward on the blade and that with this there is a drooping of the acromion, but that mal-development does not necessarily occur in the humeral head, which is retained in articulation with the glenoid surface. The mal-development does not always occur in high grade as evidenced by Cases 42 and 295 and moreover may be confined to one side only. The condition has nothing in common with any form of pathological dislocation in which the humeral head leaves the glenoid fossa.

As regards frequency of glenoid mal-development, it may be stated that these three cases represent a survey of 730 skeletons. The three are all white males and in the collection examined there were 489 white males. No case was found in the examination of sixty-six white females, 143 negro males, or among thirty-two negro females. It is also worth recording that in this total of 730 skeletons no case of congenital dislocation of the femur or radius was discovered.

DISCUSSION

There are several suggestive points in this discussion which should receive brief notice.

In the first place it is not incomprehensible that a deformity such as I have described should be associated sooner or later with a nerve lesion. The head of the humerus is not in the glenoid socket; there is no glenoid socket in which it could lodge but merely a glenoid surface; the humeral head is more mobile than usual and the shoulder posture is abnormal. I have already shown in a previous communication to the ANNALS OF SURGERY how faulty posture of the shoulder may act as a causative factor in a nerve lesion of the brachial plexus.[5] It is not necessary to dwell further upon this point at the moment.

Secondly, one may question the real congenital character of the condition. This is done genuinely enough, but the question itself implies imperfect acquaintance with the principles of skeletal formation. We are gradually emerging from total ignorance of these principles though much light is still necessary upon the subject. W. W. Graves, whose scapular studies are well known, has examined and studied in detail the scapulæ of our entire series[6] and has allotted them to his different types. I use the word types advisedly. We are still in the habit of using the term *variation* quite loosely. To quote a recent address by Bateson[7]: "It had been decreed that when varieties of a species coexist in nature, they must be connected by all intergradations, and it was an article of faith of almost equal validity that the intermediate form must be statistically the majority, and the extremes comparatively rare." This kind of fallacious reasoning has been combated by Graves for a decade and yet there are those who, largely in ignorance, seek to maintain that one of Graves' types of scapula can become transformed into another during life. The same unfortunate reasoning is utilized by those who affirm that such scapular forms as are exemplified in Fig. 2 may be the result of acquired conditions during life. Fuller knowledge of the skeleton must finally dispel this assumption already clearly unwarrantable. It is useless to protest that the condition need not have been present at birth. The scapular studies by Graves show conclusively that the form of the scapula is predetermined before ossification takes place. In No. 635 we have not a dislocation it is true, but we see a condition, undoubtedly congenital, in which the head of the humerus is equally certainly posterior.

The third problem is to pick out of the literature those cases which plainly belong to this category. As I have said, the radiograms published convey so imperfect a picture that they are useless. We must therefore depend upon features cited by the author. I do not here propose to analyze all the literature but will content myself with two references. Usually one finds merely the barest indication of what the pathological condition actually was, even if operation was performed. For example, in his first communication Peckham states,[8] referring to his Case I, that the head of the humerus refused to stay in the socket and that no examination of the glenoid was

made with the finger, yet the glenoid was "apparently normal." I doubt very much if this glenoid was actually normal, but can make nothing out of the published radiogram. In his second communication Peckham's[9] case appears to have had some flattening of the humeral head and some slight curving of the acromion, but the glenoid itself does not impress me as deformed.

Turning from these cases to those cited by Thomas,[4] we note two very significant and careful observations which to my mind point indubitably to the fact that Thomas was dealing with instances of true congenital posterior "dislocation." The first is the boy of seven and a half years who presented himself in 1910. "Operative reduction of the dislocation," confesses Thomas (4, p. 208), "was not completely successful. . . ." This is exactly what one would expect in operative treatment of the condition. The other case is that of the orthopædic surgeon (4, p. 211), who showed a "marked bending downward and forward of the acromion." In brief, it is the associated anomaly of the acromion which must be our best guide to the condition clinically and in searching the literature.

SUMMARY

Posterior congenital "dislocation" of the humerus, as illustrated in the Hamann Museum at Western Reserve University, provides the following information:

1. It is of the subacromial type and differs from pathological dislocation in the fact that the humeral head never leaves the glenoid surface.

2. It results from a mal-development confined to the scapula and not affecting the humeral head. The mal-development is in the dorsal part of the scapular neck, so that the glenoid surface is rotated on to the dorsum of the blade. Accompanying this is a drooping of the acromion over the shoulder.

3. Congenital "dislocation" is a high grade of the deformity just described, which, however, may be of slight development and unilateral or bilateral.

4. The condition was found in three white males only among a random sequence of 730 complete human skeletons distributed as follows: 489 white males, sixty-six white females, 143 negro males, thirty-two negro females.

5. In the collection just mentioned there is no case of congenital dislocation of femur or radius.

6. Posterior congenital dislocation of the shoulder is not a true dislocation since the humeral head never leaves the glenoid surface. It is undoubtedly "posterior" and all the evidence goes to show that it is really congenital in occurrence since it makes its appearance coincidently with the original scleroblastic formation of the scapula.

7. There is no inherent reason why this postural deformity should not be associated sooner or later with a nerve lesion.

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FRACTURES OF THE CAPITELLUM AND TROCHLEA

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Fractures of the articular processes of the distal end of the humerus are quite uncommon. A search of the literature reveals only seventeen cases. These include fractures of the whole or part of the capitellum, of the upper portion of the trochlea, and of the capitellum and the trochlea together. The lesion is simply a splitting off of the articular face of the bone by a fracture through the cancellous bone, the fragment consisting only of the articular cartilage and a thin strip of underlying bone. The fracture is intra-articular and the fragment lies free in the joint. The mechanism of the fracture is not definitely known, but from an analysis of the case histories it would appear that the fracture is caused by one or two mechanisms: first, by a blow on the upper end of the dorsum of a partially flexed forearm, transmitting the force through the articular end of the ulna and the head of the radius to the capitellum and trochlea; second, by a fall on the extended forearm, the force being transmitted through the long axis of the radius and ulna in such a way that the head of the radius separated the articular cartilage of the capitellum, the coronoid process acting in the same way upon the trochlea. That the radius may impinge upon the capitellum has been shown by Wilms,[1] who found a depression in the capitellum, which was made by the head of the radius.

The fragment is, as a rule, displaced anteriorly, within the capsule to the front of the humerus so that the fractured surface of the fragment is in contact with the humerus and the articular face points outward or anteriorly. In a case of Flint's,[2] however, the fragment lay against the side of the head of the radius and the outer surface of the capitellum. The fragment may also be displaced posteriorly, remaining still within the capsule. Kocher,[3] in his monograph, "Fractura Rotuli Humeri," reports four cases, in three of which the fragment was found to lie posteriorly but still within the capsule. Two cases reported by Lorenz[4] were similarly displaced posteriorly. In the remaining fifteen cases included in this analysis, the fragment was displaced into the anterior recesses of the joint, and in eight of these bony union had occurred between the fragment and the humerus.

The first case on record was described by Hahn[5] in 1852. A woman of sixty-one years of age fell, striking on the hand and extended forearm. There was extensive swelling of the elbow joint, pain on motion, but no change in the normal landmarks of the elbow. Because of the unusual clinical features the case was followed, and four years later the specimen was obtained at autopsy. Dissection showed a fracture of the capitellum, anterior displacement, and bony union with the humerous.

Kocher in the description of his four cases called attention to the clinical finding of crepitus, and that in posterior displacement the fragment becomes

wedged between the olecranon process of the ulna and the posterior recesses of the joint.

One case occurred in a female fourteen years of age. Operative removal of the fragment by opening into the joint cavity was undertaken in three of the cases with improved motion of the joint and the cessation of spontaneous pain. The etiology in all of the cases was a fall or a blow on the slightly flexed forearm.

Steinthal[6] reported a case similar to that of Hahn in a young man. The fragment, consisting of the articular portion with a thin layer of underlying bone, was removed at operation. Wright[8] describes a case occurring in a female twelve years of age with operative removal of the capitellum. This fracture was distal to the epiphysial line.

An operative removal of the fragment was done by Cotton[7] on a female forty years of age who had sustained a fracture of the capitellum by falling down six steps striking on the left elbow. Six months later there was two-thirds normal function of the joint.

Stimson[9] cites a case occurring with compound fracture involving the condyles; also a second case with a partial separation of the capitellum, in which suture was done with a fairly good result; and a third case in which the fragment had united with the front of the humerus and was removed at operation.

An interesting feature of the two cases reported by Lorenz is the method of production of the fracture. Both were in young men, twenty and twenty-two years old respectively. One was swinging a heavy hammer, the other hammering with a heavy bar of iron. The force of the blow was transmitted through the hand and forearm, the head of the radius driving off the capitellum. There was posterior displacement of the fragment in both cases, removed at operation. A different mechanism producing anterior displacement is illustrated by the cases reported by Darrach.[10] A male, age thirty-five years, slipped on the sidewalk and had fallen first on his palm, then on his elbow. There was considerable pain at once, which was referred to the front of the elbow and made worse by extension. He was operated on six days after the injury, an incision being made through the anterior capsule. The capitellar fragment was located lying in front of and above its normal site. It was removed, its broken surface wiped free of newly formed granulation tissue, washed with hot saline and replaced after the humeral surface had been freshened. The radial head seemed to hold the fragment in position, so no attempts were made at fixation. A second case[11] occurred in a female aged sixty years, who fell on the ice, striking directly on the elbow flexed at a right angle. The X-ray showed a semicircular fragment of bone lying in the anterior recesses of the joint in front of the humerus. There was a line of fracture to be seen above the capitellum. At operation under local anæsthesia the capitellum was found to be fractured but not displaced, the loose fragment being the trochlea.

The outstanding features of the clinical picture of the cases reported in the literature, together with those of the cases presented here, are: (1) Spontaneous pain in the region of the fracture, not dependent upon motion; (2) No change in the normal landmarks of the elbow; (3) Progressive limitation of movement of the elbow-joint to fifteen degrees; (4) The finding on palpation of a bony projection in the antecubital fossa; (5) Crepitus caused by a loose body in the joint.

The characteristic X-ray appearance in these cases is that of a shadow in front of the lower end of the humerus which has the contour of the

articular surface of the joint, which is either transversely or obliquely placed, and absence of the normal cortical articular marking in the region of the lower end of the humerus from which the fragment has been broken off. The absence of a defect in the antero-posterior view is explained by the fact that the articular surface which is broken off and displaced points to the front and that the posterior portion of the lower end of the shaft in the region of the fracture is left intact. The displaced fragment early begins to undergo changes, due to bone absorption and proliferation, followed by union with the bony surface upon which it lies. The proliferation of bone may give rise to an incorrect diagnosis of myositis ossificans. The articular cartilage undergoes little change in appearance.

The treatment is excision of the fragment. Darrach replaced the capitellar fragment in one of his cases. The radial head seemed to hold the fragment in position. But after ten weeks the fragment had rotated outward a little. If the fragment unites in malposition and is accompanied by excessive new bone formation, there is limitation of motion of the joint and constant pain from the resultant traumatic arthritis.

These fractures are distinct from the Posada [12] type of fracture, which is above the attachment of the ligament of the joint, and also from the fracture through the epiphysial line in children, which, as has been described by Ashhurst,[13] are extra-articular.

Case I.—L. R., female, age sixty-one years, admitted to the service of Dr. D. B. Phemister, at the Central Free Dispensary, March 9, 1914, complaining of pain and swelling of the right elbow region, which followed an injury sustained two months previously. At that time she fell down two steps, striking on the outstretched hand. She was able to move the forearm on the elbow joint immediately ofter the injury, but since then, because of the pain and swelling, has held the joint immobile.

Examination shows a swelling of the elbow mostly in front. The forearm will flex on upper arm to only ninety degrees; will extend to about thirty-five degrees. Pronation and supination seem normal. There is only slight pain on making passive movement of the joint.

X-ray examination in the lateral view, Figure 1, shows a semicircular shadow lying in contact with the anterior surface of that of the humerus, beginning about one centimetre above the line of the elbow joint. The outline of the main portion of the shadow corresponds to that of the capitellum in its lateral view. This shadow is marked in its lower half by two small curved lines which correspond to the outline of the cortex of the grooves which lie to the mesial and lateral sides of the intercondylar ridge. In the line of the elbow joint the curved shadow produced by the trochlear surface is present, while that of capitellum and intercondylar ridge is absent. In the antero-posterior view, Figure 1, the shadow of the articular surface of the lower end of the humerus is present only in the region of the mesial three-fourths of the trochlea. Lateral to this point it is replaced by a faint, irregular line and the cartilage space cannot be made out. There is an indefinite shadow overlapping that of the humerus in the intercondylar region, which is produced by the displaced fragment. The patient refused operation and has not subsequently been seen.

FIG. 1.—A. Articular surface of capitellum. B. Articular surface of intercondylar groove. C. Irregular outline of fracture surface of the humerus. D. Articular surface of the trochlea.

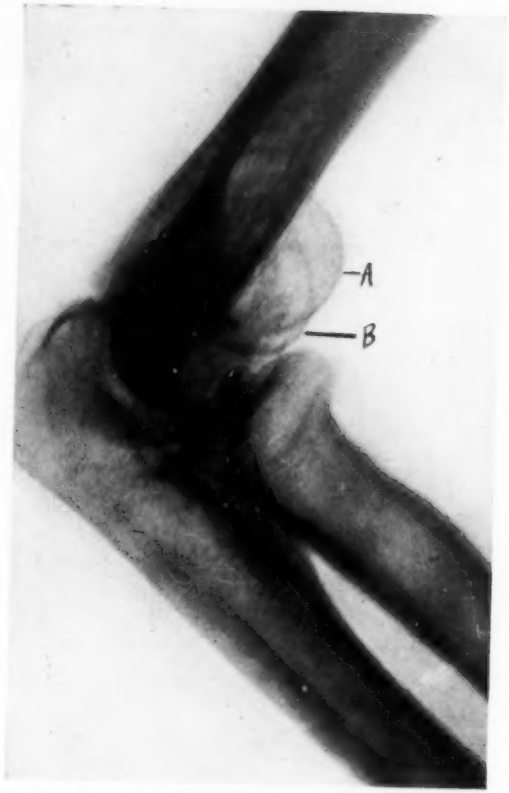

FIG. 2.—A. Articular surface of the capitellum. B. Articular surface of the intercondylar groove.

FIG. 3.—A. Lower margin of density caused by displaced fragment. B. Decreased density of external condyle.

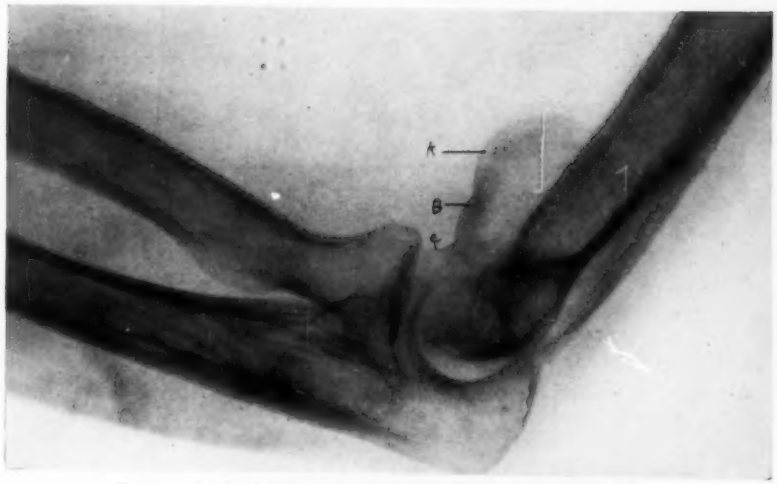

FIG. 4.—A. Capitellum. B. Intercondylar groove. C. Trochlea.

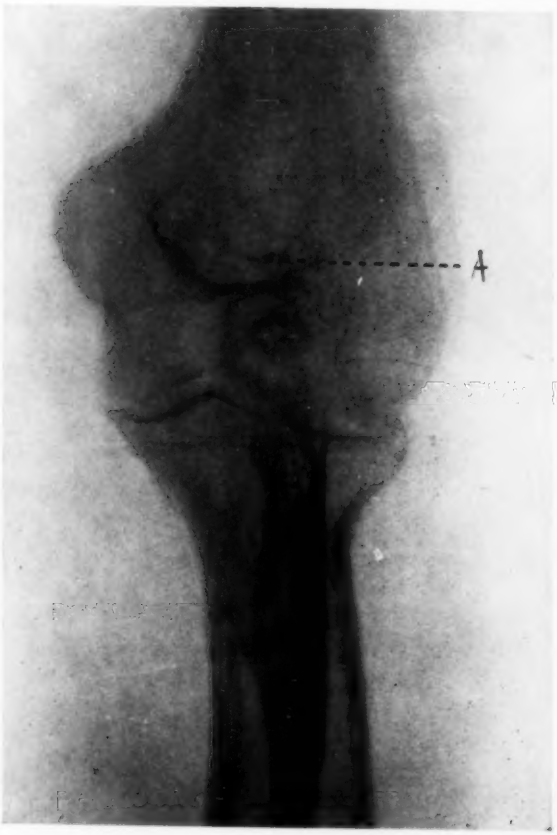

FIG. 5.—A. Density caused by fragment.

CASE II.—C. A. T., male, age twenty years, admitted to the service of Dr. D. B. Phemister, at the Presbyterian Hospital, September 9, 1914, complaining of pain in and limitation of motion of the left elbow joint. Six months previously he fell upon his left hand with the arm completely extended. Following the injury he had severe pain in the elbow with loss of motion and marked ecchymoses of the skin of the arm. A diagnosis of dislocation was made at the time and an attempt at reduction was made under anæsthesia without appreciable change in the condition. The arm was bandaged and carried in a sling for four days. He did not use the arm for two months, then found that both extension and flexion were limited. Since then there has been no change.

Examination shows arc of movement, flexion and extension of left forearm limited to fifteen or twenty degrees, pain on forced movement. No crepitus or swelling is present. An oval bony swelling is felt on deep palpation over the anterior surface of lower end of humerus. Pronation and supination are normal.

X-ray examination. In the lateral view, Figure 2, there is a faint semicircular shadow lying in contact with the anterior surface of the lower end of the humerus. Two semicircular markings of about the same diameter can be made out, one produced by the articular cortex of the capitellum and the other, lying one centimetre lower, by that of the trochlea. In the line of the elbow joint, instead of the normal curved outlines of trochlea and capitellum, a faint, blurred articular surface is seen. In the antero-posterior view, Figure 3, the width of the cartilaginous space of the elbow joint is approximately normal and the condylar ridges are filled out with bone, but the shadow cast by the external condyle is fainter than normal and the line of the articular surface of the lower end of the humerus is blurred and irregular over the capitellar and mesial trochlear regions. There is a faint transverse shadow in the intercondylar region, beginning three-fifths of an inch above the line of the joint. Its lower margin corresponds to the outline of the capitellum, intercondylar ridge and the greater portion of the trochlea. In this case there has been considerable regeneration in the region of the defect.

Operation, September 22nd. A longitudinal lateral incision was made, exposing the anterior portion of the joint capsule incision. A fragment of bone was found attached by fracture surface to anterior surface of humerus. It was removed and the wound closed.

When last heard from, five months later, there had been little improvement in the arm, motion being still limited and slightly painful.

CASE III.—S. L., female, age fifty years, admitted to the service of Dr. Dean Lewis, at the Presbyterian Hospital, September 27, 1921, complaining of pain in the left arm with limitation of movement at the elbow joint. About three months previously, while stepping onto the curb, she fell, striking on posterior surface of the left elbow. There was considerable swelling of the elbow with loss of function, ecchymoses into the skin and pain both when held quiet and when passive motion was attempted. The pain grew steadily worse until the joint was immobilized by application of a cast six weeks before admission. Arc of movement, flexion and extension of the left forearm at this time was about fifteen degrees; pronation and supination being normal. Considerable swelling still remains about the joint anteriorly, where it is also very tender.

X-ray examination: The lateral view, Figure 4, shows a faint bony shadow extending upward from the joint on the anterior surface of the humerus. Its anterior margin corresponds in outline from above downward with that of the capitellum, intercondylar ridge and lateral portion of trochlea. The shadow is continuous with that of the humerus, as if bony attachment had occurred. In

the line of the elbow joint the curved shadow produced by the remaining trochlear articular cortex can be seen, but that of the capitellum is absent. In the line of the elbow joint the curved shadow produced by the remaining trochlear articular cortex can be seen, but that of the capitellum is absent. In the antero-posterior view, Figure 5, the shadow of the articular cortex of the lower end of the humerus is likewise seen in the region of the mesial two-thirds of the trochlea, but is absent lateral to this point, where it is replaced by a faint, irregular line. There is a very faint indefinite shadow extending obliquely upward and outward from the trochlear region, overlapping the humerus shadow, representing the outline produced by the displaced bony fragment.

Operation, November 18, 1921: Longitudinal lateral incision of the left antecubital fossa. Capsule of joint opened. On the joint surface of the humerus above is a dome-shaped smooth elevation produced by the articular cartilage of the capitellum, with the trochlea extending downward to the line of the articulation. Bone which was adherent to humerus removed in pieces by rongeur forceps. Closure made of the wound. On November 26th there was a greatly increased arc of movement of the left forearm, almost twice that before operation. Pain was absent.

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INJURY OF THE LIMBS DUE TO BACK-FIRE

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The back-fire injuries are nowadays one of the commonest met with in the forearm (thirty-six per cent.). These injuries have been described for the last twenty years under the designation of "chauffeur's fracture" which became a synonymous term of the fractures of the lower radial third due to this cause. The aim of this paper is to prove that such a restricted meaning does not correspond to the clinical findings, and to complete some commentaries already given in another paper (Annals of Surgery, February, 1922).

I have examined several cases, records and skiagrams of 190 patients who have met with back-fire injury and the facts and conclusions arrived at can be summarized as follows: In 141 cases there was a definite type of bone lesion, and in the forty-nine remaining the injury had been limited—in the great majority of cases—to the soft structures of the lower forearm.

The bony lesions found were distributed as follows: Fracture of the radius alone, ninety-five cases; fracture of the ulna, one case; fracture of the radius and ulna, twenty-eight cases; fracture of the carpal bones, nine cases; fracture of the radius and scaphoid, one case; fracture of the ulna and scaphoid, one case; fracture of metacarpal, one case; fracture of humerus, one case; fracture of clavicle, one case; fracture of femur, one case; luxation of elbow, one case. Total, 141 cases.

Five of the above lesions were due to direct trauma and the remaining were all cases of the indirect type of injury.

The *radius* is the most commonly involved bone and it was fractured in 124 in a total of 141 cases (Figs. 1 and 2). The distribution of the line and types of fracture is rather irregular, showing, however, a remarkable prevalence for the lower third of the bone.

If the lower radial third is divided in three equidistant zones, it will be seen that it is in the lowermost portion that the fractures more commonly occur. In fact, sixty-nine fractures were seen at this level (Fig. I, Figs. 27 to 95, and 21 at the uppermost third of the lower radial third, Fig. I, Figs. 2 to 22). The middle third of the radius was free from injury. Although there were four cases of fracture to be seen at the middle third of the lower radial third (Fig. I, Figs. 23 to 26). In one single case there was a vertical short split of the inner brim of the radial head (Fig. I, Fig. 1).

The direction of the line of the crack at the lower end of the radius can be divided into transverse and oblique. The former are usually found at the upper third zone and in the epiphysial and supra-epiphysial fractures. The transverse split was seen in sixty-two cases (Fig. I, Figs. 2 to 63). In the thirty-one remaining the crack ran obliquely inwards and downwards in a complete line in the great majority of the cases (Fig. I, Figs. 64 to 95).

These oblique splits form the so-called variety of intra-articular fractures, and the fractured piece has a triangular appearance.

The lower internal angle of the triangle falls in the articular surface as follows: In twelve cases it was seen at the inner lower end of the radial articular zone (Fig. I, Figs. 64 to 75); in seven it ended in the interval between the centre and the inner end (Fig. I, Figs. 76 to 82); in seven at the centre of the articular surface (Fig. I, Figs. 83 to 90); in five at the outer side of the centre, forming a good type of styloid fracture (Fig. I, Figs. 91 to 95); and in one rare case the crack was of the double and combined type of oblique-central and inner-transverse epiphysial separation (Fig. I, Fig. 69).

This shows, therefore, that fractures of the styloid process are not so common as those extending to the inner side of the middle of the articular line. The longitudinal or medullary split was not seen in any case of the series.

With regards to the direction of the displacement of the fragments it can be said that they are usually seen to be inclined forwards in the upper third fracture of the lower radial third. Sometimes the distal portion is slightly projected inwards.

In the transverse fractures of the lowermost third of the lower radial portion it is noticeable that the proximal fragment is usually displaced forwards, and the lateral skiagram reveals, as a rule, a broader widening of the fracture space at the anterior side of the bone. This separation is ordinarily more obvious at the outer border of the bone, and occasionally it will be noticed some impaction of the fragments at the inner end of the bony diastasis. In fact, the gap is wider at the antero-external part of the radius, and this fact applies even to the triangular fractures of the lower radial epiphysis.

There were five cases of Colles' fracture in which the deviation backward of the lower fragment was well displayed. On the other hand, there were two cases of *reversed Colles or Goyrand fracture.*

The ages of the cases were distributed as follows: Between ten and twenty years, twenty-six cases; between twenty-one and thirty, forty-two cases; between thirty-one and forty, twenty-five cases; between forty-one and fifty, two cases. Unknown, two cases. This shows a predominance of back-fire fractures in fully developed bones. In fact, I have shown in other articles that age has apparently no bearing on the fracture being at the epiphysial line, which can be proved by looking at Fig. 1, where the age of the case is shown by the side of the fracture.

Ninety-five cases were of the right and two of the left forearm. Two were females and ninety-three males.

These cases were seen as follows: Within seven days of the accident, six cases; within thirty days, twelve cases; within six months, twelve cases; within one year, two cases; within eleven years, five cases.

These facts demonstrate the lower radial end to be the commonest seat of

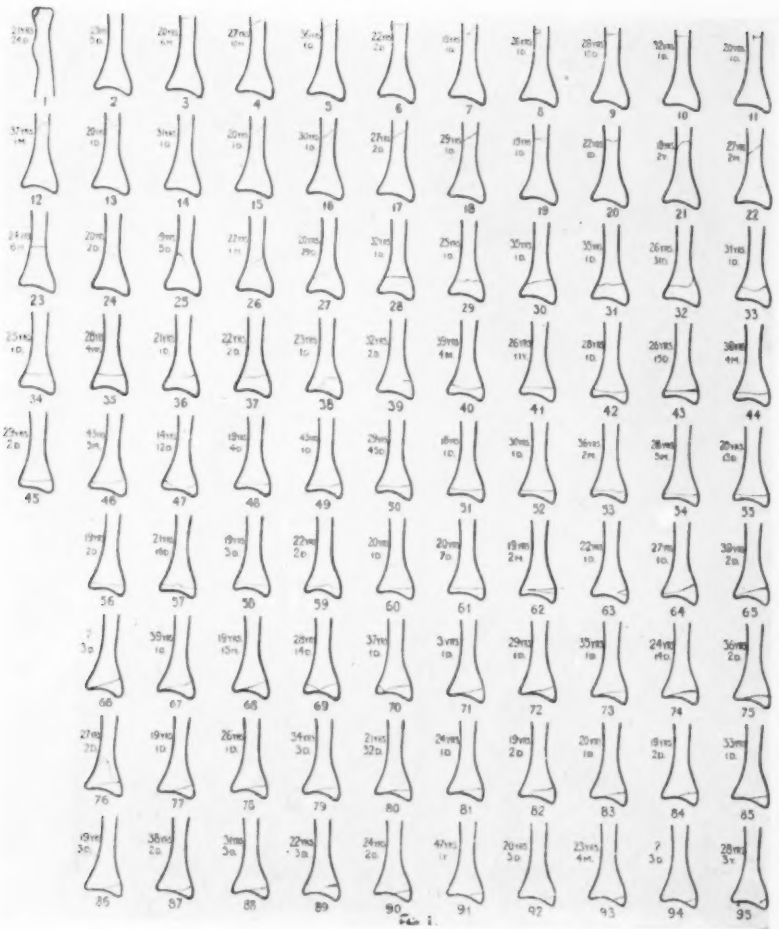

FIG. 1.—Shows ninety-five single back-fire fractures of the radius. Fig. 1 is a rare example of upper radial third fracture. (The ages of the cases and the dates when seen are given at the left-hand side of each figure.)

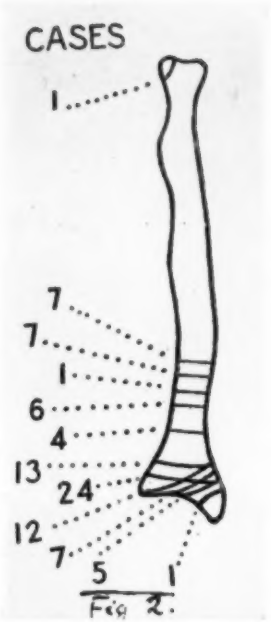

FIG. 2.—This diagram has been obtained by superimposition of all cases of Fig. 1. It is a synthetic diagram.

FIG. 4.—Shows a rare case of single ulna back-fire fracture.

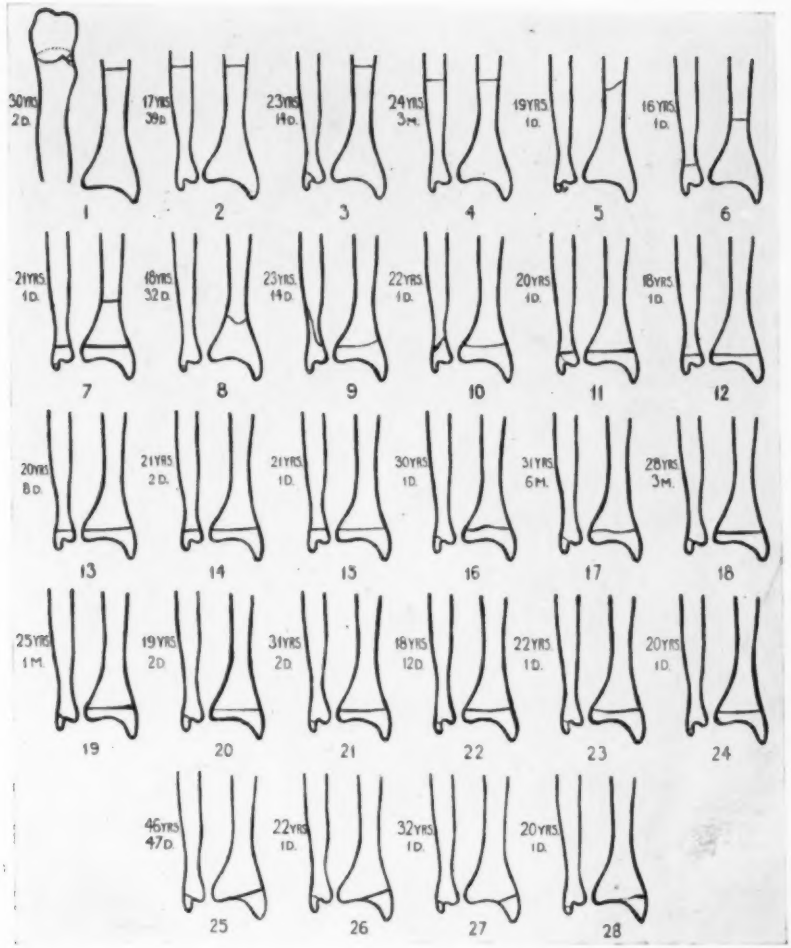

FIG. 5.—Shows twenty-eight cases of double forearm back-fire fracture.

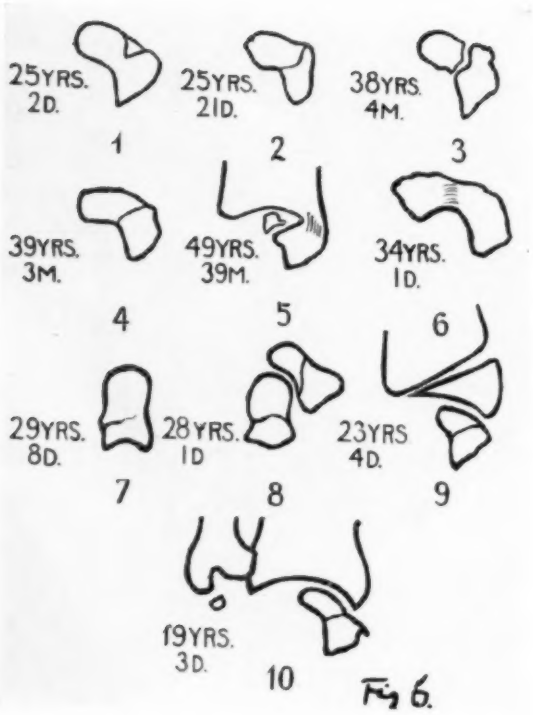

FIG. 6.—Shows ten cases of carpal back-fire fracture.

back-fire fracture (seventy-two per cent.). The epiphysial transverse crack is the commonest and the supra-epiphysial the next common.

Among these cases there was a case of recurrence of the fracture (Fig. I, Fig. 13), five months after the first accident.

In one case (Fig. I, Fig. 18), the cuneiform appeared pushed into the ulna, and the lower radial fragment was detached outwards and backwards.

In another case (Fig. I, Fig. 35), the radius was the seat of a very marked deformity. This fracture occurred four years previously, and the distal radial fragment was deviated as in the previous fracture. There was an apparently well-defined double supranumerary formation at the ulnar styloid neighborhood, which appears to be the "ulnare antebrachii" and the "triquetrum secundarium."

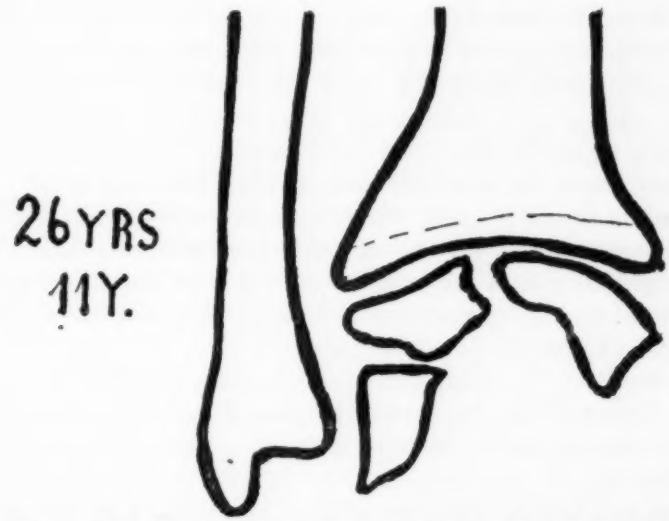

FIG. 3.—Shows a case of stopped growth of the lower radial epiphysis two years after back-fire fracture.

In Fig. I, Fig. 41, and Fig. 3, is exemplified a case of stopped growth. The accident occurred eleven years previously and the forearm appeared like a case of Madelung deformity.

In some cases the radiographic appearance of the bone lesions is only limited to a shadow at the epiphysial line (Fig. I, Fig. 42). This is rather frequent and forms a good radiographic appearance of the so-called *epiphysial strain*. There were twenty-four epiphyseal separations (Fig. I, Figs. 32 to 63), of which two were incomplete (Figs. 62 and 63). There were ten greenstick fractures (Fig. I, Figs. 78, 11, 14, 25, 33, 37, 62 and 95).

Two of the radial fractures were due to the direct action of the handle.

The *ulna* alone was fractured in two cases. These fractures occurred at the lower third of the bone as follows: In one the crack was complete and of the transverse type, at the upper third of the ulnar lower third. There was a marked anterior bowing of the fragments. In the other case (Fig. 4),

the crack ran obliquely upwards and inwards in the lower end of the bone in a spiral fashion. This fracture is a rare type of lesion. The ages of these individuals were twenty-one and twenty-five years. This shows the rarity of the single ulnar back-fire fractures.

The distribution of the *combined radial and ulnar* fractures was as follows: Radius, upper third of the lower third, six cases (Fig. V, Figs. 1 to 6); middle third of the lower third, one case (Fig. V, Fig. 7); and lower third of the lower third, twenty-one cases (Fig. V, Figs. 8 to 28). Ulna, coronoid, one case (Fig. V, Fig. 1); upper third of the lower third, two cases (Fig. V, Figs. 2 to 4); epiphysial, nine cases (Fig. V, Figs. 6, 7, 9 to 15); styloid, sixteen cases. Among the last there were four cases which apparently resembled the "os triquetrum secundarium" or the "ulnare antebrachii" (Fig. V, Figs. 7, 8, 24 and 28).

If the radius is analyzed by itself it will be seen that the commonest variety of split corresponds again to the epiphysial separation (seventeen cases); the transverse crack at the upper third zone of the lower radial third is the next common and occurs in six cases; and in the four remaining the fracture has a triangular shape and was located at the styloid portion of the bone. In fact, the radius behaves exactly as when fractured alone.

The ulna, on the other hand, reveals very interesting features in its back-fire traumatology. Thus, the styloid tip is the most vulnerable portion of the bone (eighteen cases). Among these cases four, however, appear to be normal separations or congenital non-fusions. The epiphysial line is the next in order of frequency (nine cases).

In one case (Fig. V, Fig. 25), there was a wedge cut off at the back of the distal ulnar fragment, and the same occurred in Fig. V, Fig. 26, at the corresponding portion of the radial triangular bit. These are special cases of marginal fracture.

The ulna was broken above the level of the radial fracture in one case only (Fig. V, Fig. 11). This was a very interesting fracture of the outer coronoid brim and already alluded to (ANNALS OF SURGERY, February, 1922).

The ages of these individuals and the time when seen are shown by the side of the diagrams.

There were eleven cases of *carpal injury*, as follows: Fracture of the scaphoid, four cases (Fig. VI, Figs. 1 to 4); fracture of the scaphoid with extrinsic radial synostosis, one case (Fig. VI, Fig. 5); compression fracture of the navicular-semilunar junction, one case (Fig. VI, Fig. 6); fracture of os magnum, one case (Fig. VI, Fig. 7); fracture of the scaphoid and os magnum, one case (Fig. VI, Fig. 8); retro-ulnar luxation, one case. These cases have been described elsewhere (*Surg., Gyn. and Obst.*).

In one case the proximal scaphoid portion was removed by an open operation, and in the case of the retro-ulnar dislocation, the displacement was reduced under general anæsthesia. This patient was thirty years of age and was seen a few moments after the accident.

The triangular fracture of the *radial styloid associated with compression fracture of the navicular neck* was seen in one case (Fig. VI. Fig. 9). The lateral skiagram reveals the radial gap to be wider at the front of the bone, and a backward dislocation of the lower scaphoid.

In one case the *scaphoid fracture was associated with a crack of the ulnar styloid* (Fig. VI, Fig. 10). This case was probably a supernumerary bone. Although it cannot be definitely stated as such, on account of the irregularity of the edges of the split, and some slight periosteal thickening around the proximal styloid segment. These facts point to the vulnerability of the scaphoid, which was broken in seven per cent. of the total cases of the series.

The back-fire fractures are essentially, as it was shown above, fractures of the wrist. The radius is more commonly involved, as it is the most fragile bony structure of this anatomical region. The surprising fact lies in the comparative frequent lesion of the ulna lower end, which is not the rule in the general traumatology of this bone. The scaphoid is the next important structure involved.

The flexion hypothesis (Ghillini), the traction theory (Lucas-Championnière, Destot, Sorel, Walther), . . . the abduction mechanism (Caccia), explain some of these fractures only. In fact, the physio-pathology of the back-fire fracture is complex, because it concerns a multitude of anatomical attitudes, physiological possibilities, and mechanical stages which render the problem of its systematization a difficult task.

The combined flexion-compression theory (Cotton, Pilcher, Stevens) appears to explain the well-known fact, revealed in some cases by the X-ray examination, of the wider opening of the fracture at the ventral surfaces of both radius and ulna, as it was shown above. The same fact was demonstrated in some cases at the outer border of both radius and ulna (Fig. I, Figs. 43, 74, 89; Fig. V, Figs. 10, 11, 28; Fig. X, Fig. 9). These appear to be types of injury in which a marked degree of wrist adduction or abduction was added to the trauma. The hyperextension of the wrist appears to be the dominant feature of these injuries. Although there is always another extra element which seems to be an auxiliary, as it were, in promoting the enormous variety of these fractures. May it be the degree of lateral position and strength of the pull at the wrist, which are therefore added to the hyperextension. It appears that by the abduction of the wrist, accompanied by more or less marked degree of extension, the naviculo-radial contact becomes more intimate and a fracture compression of the radius or navicular, with or without scaphoid luxation, may occur. If the abduction is even greater, the internal lateral ligament of the wrist may be forcibly dragged downwards, and a similar phenomenon, as seen in the ankle fracture-dislocations, may take place here. This appears to be the best explanation of the common fractures of the ulnar styloid.

I have tried elsewhere to discuss the physio-pathology of the carpal injuries. The os magnum fracture, as it is said, appears to be due to pressure

of the navicular foot. I could find no clinical evidence of Sebileau's suggestion. He maintained that in some cases the starting handle of the motor goes back and stops suddenly. This will produce a sprain over the os magnum and perhaps rupture of the interosseous ligament between this bone, the unciform and the trapezoid.

The radial diaphyseal fractures occur at the lower portion of the shaft "where the junction of the triangular with the quadrangular sections of the bone takes place. The hand is fully supinated" (Caccia). This suggestion, based on mechanical basis, appears to be not entirely satisfactory. In fact, the supination is not the commonest attitude of the forearm while starting the engine, whereas these fractures are undoubtedly the most frequent in practice.

The degree of forearm flexion at the elbow, the amount of pronation, and the extent of forearm extension and arm abduction appear to explain the fractures of the radial head and the ulnar coronoid. In fact, there may be pain at the elbow or even at the shoulder without noticeable bony lesion (Ghillini, Sir R. Jones' case). Fig. I, Fig. 91, is a good example of humero-scapular concussion, and the pain was even marked for some months after the radial fracture. This mere pain is a minor stage preceding the fracture, and, contrary to Ghillini, it may occur even in cases of lower radial fracture.

Nervous injury was not seen among these cases. The injury may be due to the elongation of the nerve.

The third metacarpal bone was fractured across at its base in one case.

The humeral epitrochlea was broken in another case. They were both direct injuries.

The elbow was the seat of a dislocation in one case which was reduced a few hours after the accident. The ulna was displaced backwards and the radius backward and slightly outward. The tip of the olecranon was fractured as well.

The middle of the clavicle was fractured in one case "starting a lorry, the shoulder cracked." The last two cases were of the indirect variety and show the remarkable types that these lesions display. They are both good instances of distant effects of the trauma.

The inner condyle of the femur was broken in the case of a man forty-six years of age. The fracture was very slight and looked like a scale being taken off the condylar surface. It was due to the direct hit of the handle.

The above lesions show the great variety of fractures due to the direct hit of the handle or to the indirect pressure caused by the sudden backstroke of the engine.

The elbow luxation and the clavicular fracture are peculiar. The former appears to occur while the handle passes the two lower quadrants of its circular rotation, whereas the latter seems to take place in the two upper quadrants.

There were forty-seven cases of lower forearm *contusion,* which gave

negative radiographic evidence. The ages of these individuals were as follows: Between ten and twenty years, twenty cases; between twenty-one and thirty, fourteen cases; between thirty-one and forty, ten cases; over forty, three cases. They were seen: Within the first week of the accident, thirty-five cases; within the first month, seven cases; within the first six months, three cases; after the first year, two cases. The swelling over the lower radial region was obvious in the great majority of these cases, and in some a slight ecchymotic tint could be demonstrated around the wrist. The pain, however, is not localized as in cases of real fracture. It appears to be diffuse and irradiating towards the elbow at the back of the forearm. Although in some cases the styloid line appeared to be the maximum point of tenderness elicited by means of gentle finger tapping. These cases are good instances of *epiphysial strain*. In fact, these lesions, as it is shown above, are commoner among young individuals. A careful radiographic search reveals nothing abnormal. The clinical picture illustrates a condition previous to widening of the epiphysial line, which in its earlier stages is revealed radiographically by a faint shadow at the epiphysial junction. The next more advanced lesion appears to be widening of the epiphysial space at its outer anterior end, which precedes the real epiphysial separation, as it has been demonstrated above.

In one case seen three years after the accident, the hand was slightly swollen and the movements of the wrist were painful at the extreme degrees of flexion.

In the remaining two cases of the series, the inner side of the knee was swollen and tender, and the skiagram revealed nothing abnormal. They were recent cases of direct trauma.

The prognosis of these lesions is as a rule satisfactory. The grasping power of the hand seems to be decreased in some individuals, and in others diffuse pains in the wrist may occur every now and then for years after the accident. Among the cases of the series, one showed marked articular pains at the shoulder ten months after a lower radial third back-fire fracture. In another rare case examined eleven years after separation of the lower radial epiphysis (Fig. 3), the radius appeared two inches shorter than its fellow, and the hand consequently was markedly adducted.

CONCLUSIONS

(1) The lower third of the radius and ulna is the commonest seat of back-fire fracture, and the carpal bones the next common.

(2) The crack through the epiphysial line of the radius is the commonest type of single bone lesion.

(3) The ulna styloid tip and radial epiphysial line are the commonest types of double bone lesions.

(4) The scaphoid is the commonest carpal bone involved.

(5) In individuals under twenty years of age the diagnosis of ulna styloid

fracture is more difficult owing to the common occurrence of irregularities of ossification.

(6) In twenty-five per cent. of the cases of the series the injury of the wrist was limited to the soft parts.

(7) The upper end of both radius and ulna are occasionally the seat of fracture.

(8) The age of the individual has no bearing on the fracture being at the epiphyseal line.

(9) The great bulk of these injuries is of the indirect type.

(10) The prognosis is usually good.

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TRANSPLANTATION OF THE ENTIRE FIBULA IN CASES OF LOSS OF TIBIA FROM OSTEOMYELITIS

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In April, 1912, the author [1] reported the results of the transplantation of the entire fibula as a substitute for the loss of the tibia in the same leg following osteomyelitis. The values of such transplants are several: First, the dangers from infection following a small exposure are largely minimized, as compared with a tibial graft. Second, failure is practically impossible, owing to the fact that the blood supply of the fibula is not disturbed. Third, the bone rapidly hypertrophies to take up the added weight and leaves no defect from the absence of the fibula. Fourth, fracture of graft is impossible.

The entire transplantation is, of course, used only in those cases following osteomyelitis of the tibia where no regeneration has occurred and the disability therefore is complete.

In practically all cases of osteomyelitis of the tibia, the upper and lower epiphyses remain the limiting barriers and are undisturbed so that the growing portions are not usually totally destroyed.

Technic of Transplantation.—Following careful preparation of the leg, an incision three inches long is made between the head of the fibula and the head of the tibia (see Drawing No. 1A) (Fig. 11) being careful not to injure or divide the peroneal nerve as it passes over the fibula.

The remaining tibia is then cupped out to take the fibula graft.

A longitudinal slit is then made in the periosteal covering of the upper fibula and the outer half gently freed from the fibula. The fibula is then osteomized as high as thought practical and by means of heavy traction is pried into this tibial cup. It is usually best to deepen this cup a little, thereby gaining better and quicker union. (See Drawing No. 1B.) (Fig. 12).

By leaving the periosteum on the outer side of the fibula intact both to the remaining fibula head and to the outer transplanted shaft, we gain a periosteal bridge which will often develop a bony bridge, thus more efficiently uniting the fibula and tibia. (See Cases I, II and III.)

The use of wire is unwise as union is always delayed in the presence of a foreign material. The wound is closed in the usual manner and a plaster applied from the toe to well above the knee. This remains on for two months, after which, a similar operation is performed on the lower leg. (See Drawing No. 2A and 2B) (Figs. 13 and 14) and diagrammatic sketch. (Fig. 10).

Usually two months following the second operation, weight-bearing is permitted, and either plaster or a caliper brace is used for a period of six to eight months.

It is surprising how quickly bone hypertrophy follows in the fibula with this added responsibility.

Note that the hypertrophy in Case I reached nearly the proportion of a normal tibia.

Observations.—1. Union is solid and takes place in record time.

2. The fibula hypertrophies, as seen in Case I of seven years' standing, and in Cases II and III of four and a half years and nine years.

3. Growth of leg continues and does not seem to be retarded.

Case I.—A. L. This was a case of a young girl who in January, 1915, had an osteomyelitis of the left tibia and the right femur. She was admitted to the hospital on June 10, 1912.

Physical Examination.—Negative except for the local examination, which showed many discharging sinuses over the left tibia and the right femur. Wassermann negative.

On June 25, 1915, the entire tibia was removed from the epiphysis to epiphysis and plaster cast applied from groin to toes. Femur curetted, troughed and packed.

On March 1, 1917, there was no regeneration of the tibia—all wounds healed.

February, 1918, upper end of fibula transplanted into upper epiphysis of tibia—wound healed with only slight discharge in three weeks.

November 4, 1920, lower end of fibula transplanted into lower tibial epiphysis.

Wound healed in three weeks. Plaster case applied following each transplant from toes to groin. (See X-rays, Figs. 1, 2, 3, and 4.)

Functional result excellent seven years after operation.

Case II.—N. G. This is the case of a young boy who had an acute osteomyelitis of the tibia in April, 1917, which resulted in marked destruction of the greater part of the tibia. This osteomyelitis was treated up to November, 1917, when the wound was healed. On May 23, 1918, the fibula was transplanted into the epiphyses of the tibia as in the previous case.

March 17, 1919, X-rays show hypertrophy of the fibula. (See X-rays, Figs. 5 and 6.)

Functional result excellent four years following transplantation.

Case III.—L. B. This young girl, at the age of thirteen, was seen by her physician for pain and discharge of the lower leg. Two years' duration. At the first onset the pain had been sudden, accompanied by temperature ranging from 101 degrees to 104 degrees. Three operations were performed, each consisting of the removal of a portion of the tibia.

April 15, 1909, this case was seen by one of the writers and the examination showed four discharging sinuses along the tibia. A diagnosis of chronic osteomyelitis was made and X-ray showed the whole tibia honeycombed and practically sequestrated.

Operation.—May, 1909, the whole tibia excised, only the epiphysis remaining. The periosteum resutured.

November, 1909, as there was no evidence of an attempt to regenerate a new tibia, the upper end of fibula was transplanted into the upper epiphysis of the tibia; the wound healed in two weeks.

December 31, 1909, the lower end of the fibula was transplanted into the

lower epiphysis of the tibia. The wound healed in two weeks. (See X-rays, Figs. 7 and 8.)

Functional result excellent twelve years following transplantation.

CASE IV.—C. W. M. Two years previous this man had a compound comminuted fracture of both bones in the right lower leg, with the loss of two and one-half to three inches of bone. He had four operations. Examination on August 22, 1921, showed a two and one-half inch gap at the junction of the middle and lower third of the tibia with a tendency to varus. The wound has since February, 1921, been healed.

Diagnosis.—Non-union of old fracture of the tibia.

August 26, 1921, lower end of the fibula transplanted into the lower end of the tibia. Wound healed in two weeks. (See X-ray, Fig. 9.)

September 20, 1921, upper end of fibula transplanted into the upper end of the tibia. (See X-ray, Fig. 9.)

December 28, 1921, lower fragment solid, upper fragment has slipped. To have another operation in two months.

February 14, 1922, upper end of fibula placed in approximation with tibia and then sutured with kangaroo tendon. Convalescence thus far uneventful. (See X-ray, Fig. 9.)

Clinically, one can see no reason why a perfect functional result should not follow.

LITERATURE

Campbell, W. C.[3]: Transference of the fibula as an adjunct to free bone graft in tibial deficiency. J. Orth. Surg., October, 1919, vol. i, pp. 625–631.

Three cases are reported by the author. In order to make the success more certain in this condition, Campbell uses the following technic: An incision in the skin about four inches in length is made over the lateral aspect of the head of the fibula, the deep fascia is incised, then the capsule of the tibio-fibular joint. All cartilage and fibrous tissue is removed from the head of the fibula, being careful not to injure external popliteal or peroneal nerves. Next a cavity is made in the inferior and external aspect for the reception of the denuded head of the fibula. Heavy traction will place the head of the fibula within the cavity, provided scar tissue between tibial fragments does not prevent. When such difficulties arise these tough bands are excised or severed, the periosteum of the fibula is sewed to the periosteum of the tibia and the wound closed with catgut throughout. The final step is to do the inlay graft in the usual manner, which needs no description. This method has been successfully employed in the three cases. The advantages of the procedure are: 1st: It is possible to lengthen the limb one and one-quarter inches. 2nd: Early transference of head will stabilize limb and prevent shortening; 3rd: At the end of eight weeks we have a stabile limb in which no false motion is possible between knee and ankle. 4th: Early stability prevents motion and facilitates the development of the free graft. 5th: New blood supply is added to the tibia through the medium of the fibula, promoting nutrition. 6th: Greater chances of complete success. One point that Campbell especially desires to emphasize is that a two-stage operation should be done in all cases where there is much difficulty in making the limb straight from contraction of dense scar tissue. Most patients will readily submit to the second operation when such marked improvement follows the first.

C. J. Bond[3]: Transplantation of the fibula; osteomyelitis. Brit. J. Surg., vol. i, p. 610, April, 1914.

CASE I.—Little girl, aged four years. Shaft of right tibia had been destroyed by osteomyelitis in June, 1904. The right fibula was cut across just below the head of the bone and this portion, with the epiphysial cartilage, was left in normal

position. The divided end of the shaft of the fibula was then pushed over to the inner side and inserted into the freshened lower surface of the tibial epiphysis, to which it was wired in position.

Within the next two months firm, bony union had taken place. Bony outgrowth took place from the isolated upper fragment of the fibula. The upper end of the shaft of the fibula began to assume the outline characteristic of the normal tibia. In March, 1907, fibula was divided just above external malleolus and lower end of shaft was displaced inward and inserted into soft cancellous tissues of the lower tibial extremity. The child now walks and runs with the aid of a high-soled boot without any noticeable limp.

Case II.—A boy, in whom the shaft of the right tibia was destroyed by osteomyelitis in 1907. This was removed as a sequestrum in November of that year when the boy was ten years old. The place of the lost tibia was supplied by transplanting the shaft of the fibula in two stages, as in Case I. At the first operation, in March, 1908, the shaft of the bone was divided just below the head. It was then displaced inwards and the cut surface wired to the freshened tibial extremity somewhat to its outer edge. In May, 1908, the lower end of the shaft was divided above the external malleolus and embedded in the cancellous tissue of the lower tibial epiphysis.

Owing to the contraction of the soft tissues of the limb, due to the absence of the tibial framework, considerable pressure was exerted on the lower end of the shaft and this gradually forced the end of the bone deeper into the spongy tissue until it eventually passed right through the epiphysis, almost passing through into the joint. Unfortunately, in this case, the disease affected the left tibia, destroying about two inches of the bone and producing a bad anterior posterior deformity of the limb at this spot; about one and one-half inches of soft bone were removed and ends of divided shaft wired together. This necessitated a subperiosteal division of the fibula at the corresponding level. A year after the operation shows a restored shaft with a single central medullary canal and no callus. It is impossible from an examination of the limb on the skiagram to say that the fracture had occurred at this spot.

H. Schloffer[4]: Zur Osteoplastik bei Defekten der Tibia. Bruns. Beitr. zur klin. Chir., vol. xxv, 1899, p. 76.

The transplantation of a graft from the fibula to the tibia was first practiced by Hahn.

Lilienthal writes of a wonderfully successful operation of this nature in a boy of nine years with absence of bony matter from the tibia due to fracture. The surgeon severed the fibula and fitted the upper end of the shaft into the tibial fragment. Within four months consolidation took place. McBurney simply sutured the head of the fibula to the tibia with favorable results.

Gangolphe[5]: Considerations sur la resection du tibia pour osteosarcomes et sur l'utilisation du perone. Lyon Med., 1909, vol. cxiii, pp. 749–751.

Patient suffering from suppurating tibia following fracture and which the author suspected of being an epithelioma. The author decided to make a large diaphyseal resection of the tibia, causing the patient to support his weight on the fibula. If the weight of the body does not exceed sixty kilometres this is possible. The author advises the use of the fibula of the other leg as, in case of some mishap in the operation, the patient stands more chance of recovery. The patient mentioned was operated on successfully by this method by another surgeon.

M. Brandes[6]: Die Heilung grösster Tibiadefkte durch Transplantation. Med. klin. Berl., 1913, vol. ix, p. 1493.

The author advises the use of the fibula of the same leg for transplantation because it is the material nearest at hand and, being usually strong and hypertrophic, is splendid material for bridging the tibial deficiency. The head of the fibula

is split and the upper end of the fibular shaft implanted in the upper fragment of the tibia and then the lower end of the fibula is implanted in the lower fragment of the tibia. The result is a fusion of the tibia and fibula into a new bone formation which permits the movement of the leg. Two children, having undergone this operation, walk easily.

Berard[7]: Greffe d'une portion du perone gauche dans une perte de substance de ten cm. du tibia droite, consecutive a une fracture pathologique avec dystrophie osseuse. Lyon Chir., 1913, vol. ix, pp. 574–8.

The patient, twenty-seven years old, had three successive fractures in the same place in seven years. The first two fractures consolidated normally. The third left the leg impotent, shortened by about three cm., curved slightly inward, and with pains. The author uncovered the tibial focus, which presented a swelling which had the appearance and consistency of an egg shell.

In the interior of this cavity was a little serosanguineous liquid and some pimples forming an interrupted membrane. After ablation of the entire diseased bony area, the author realized a loss of bony tissue amounting to nine or ten cm. at the two poles of which the medullary canal was closed by a bony shell. The author then resorted to ablation of the left fibula, without its periosteum, to a length of twelve cm. The fragment of the fibula was inserted into the medullary canal of the tibial fragments. The operative results were uncomplicated. After five months the right leg was consolidated. The patient walked easily with a metal support.

Lapeyre[8]: Autogreffe de la diaphyse peroneale pour remplacer la diaphyse tibiale necrosee et sequestree osteomyelite. Réstauration du tibia autour de la greffe. Guérison avec résultat fonctionnel excellent. Bull. et Mem. de Soc. de Chir. de Paris, 1914, n.s. vol. xl, pp. 182–90.

A child of three years came for treatment July 16, 1912, for an acute affection of the lower leg which had begun November 27, 1911. Upon the author's first examination the tibia seemed in a necrotic state, which seemed to involve nearly the whole diaphyses. The upper and lower epiphyses were curetted and cleaned. Fifteen centimetres separated the two osseous extremities. Suppuration persisted. It was vain to hope for a spontaneous reparation. On February 2, 1913, the author performed the fibular transplantation.

1. Careful curettage of the area to which the fibula was to be transplanted and extirpation of fungosities.

2. The section of the fibula at its lower extremity. The length of the graft was about thirteen cm.

The author did not dare to insert the two extremities of the fibula into the same epiphysis on account of the inflamed condition of the latter and decided to use two ivory pegs. For two or three months suppuration persisted at the upper end. At the end of three months consolidation was in progress. On September 10th the leg appeared solid. It had taken seven months to obtain this result. From a radiograph taken on this date the transplanted fibula showed itself to be completely surrounded by new bony tissue, irregular but solid. Suppuration had ceased. On December 10th, when the child left the hospital, he could walk with one cane. Thus transplantation of the fibula had saved a leg from amputation and reconstructed a useless member into a solid construction with splendid functional result.

Michon[9]: Perte de substance du tibia, consecutive a une blessure par eclat d'obus; transplantation du perone; guerison avec bon resultat fonctionnel. Bull. et Mémoires de la Société de Chirurgie de Paris, vol. 422, 1916, pp. 1719–22.

M. M. Sub-lieutenant, wounded by shell explosion on June 23, 1915, which resulted in a serious wound in the right leg. (1) A foot wound with tarsal fracture. (2) A fracture of the inner malleolus with a hole in the tibio-tarsal articulation. (3) A comminuted fracture of the medium tibia with important loss

of bony substance covering about three cm. The limb was immobilized. The inferior wounds cicatrized after prolonged suppuration. The malleolar fracture was consolidated with tibio-tarsal ankylosis and a slight degree of equinism. On January 22, 1916, seven months after the accident, the author performed a transplantation of the fibula of the same leg, following the technic of Barbet.

The operation consisted of the liberation and resection of the two tibial extremities by an internal incision and a section of the fibula by external incision. The fragment of the fibula, obtained by double section and adhering always to the interosseous membrane serving as pedicle, was thrust between these and the muscles of the anterior leg; the two extremities, bevelled, were both introduced into the medullary canal of the corresponding tibial fragment. The operation was long and tedious. The operative results were accompanied by suppuration and fever. The final results were satisfactory.

The leg is solid. The grafting is surrounded by new bony matter according to radiographs. The lower fragment of the fibula was welded to the tibia. The upper fragment was loose but caused no discomfort. The patient could walk with a cane.

P. Mauclaire[10]: Grosse perte de substance du tibia; greffon emprunte au perone du cote oppose. Bull. et Mem. de Soc. Chir. de Paris, 1916, n.s. 12, 1864–66.

Case of a soldier who was wounded by a bullet, leaving a large wound in the tibia. This produced an arterial aneurism, osteitis of the calcaneum and violent retraction of the Achillis tendon. The wound suppurated for a long period. Three months after cicatrization the author transplanted a graft from the fibula of the other leg. Above he sunk the graft into the medullary canal. Below he fastened it to the tibial groove with catgut. The author does not feel ready to advise the maximum length of bone to be taken for grafting. In the present case he used seven cm. of the fibula. In this patient the consolidation was rapid and the patient walks easily. The leg from which the graft was taken is in good condition. The tibia suffices by itself for the functions of the leg, if judged from the six cases of fibular grafts made by the author.

For good consolidation it is necessary to sink the graft in the medullary canal as soon as possible. After the grafting the author sectioned the Achilles tendon to correct the equinism, then he scraped the necrotic calcaneum. The author states his intention of getting X-ray picture of this operation after one year has elapsed.

Pierre Barbet[11]: Revue general de la reconstitution du tibia detruit par transposition du perone voisin. La Clin. Par., vol. vii, 1912, pp. 65–69.

It is evident that the Hahn-Huntington operation is beneficial. It furnishes almost certain results (showing only two partial failures in twenty-seven cases). From the functional standpoint it seems superior to other grafts. The cases show almost identical post-operative history: rapid consolidation, return of muscular vitality, progressive hypertrophy of the transplanted fibula.

This operation is then preferred before all others. (1) In cases of destruction of the bony tissue due to osseous necrosis with death or insufficiency of regenerating periosteum. (2) After periosteal resection of an osteosarcoma of the tibial diaphysis. (3) After resection of the foci of old pseudo-arthrosis, followed by fracture with atrophy of the fragments.

Bond, C. J.[12]: On the late results of three cases of transplantation of the fibula, with remarks on the process of growth and the physiological development of transplanted bone. Brit. J. Surg., April, 1914, vol. i, pp. 610–624.

Bond gives credit to Huntington as being the first surgeon to publish a case in which a successful attempt had been made to replace the whole shaft of the tibia by transplanting the shaft of the fibula into its place. The surgical results of the author's first two cases are as follows: The end results of bone transplantation in both cases (in one of which amputation had been suggested) Bond thinks

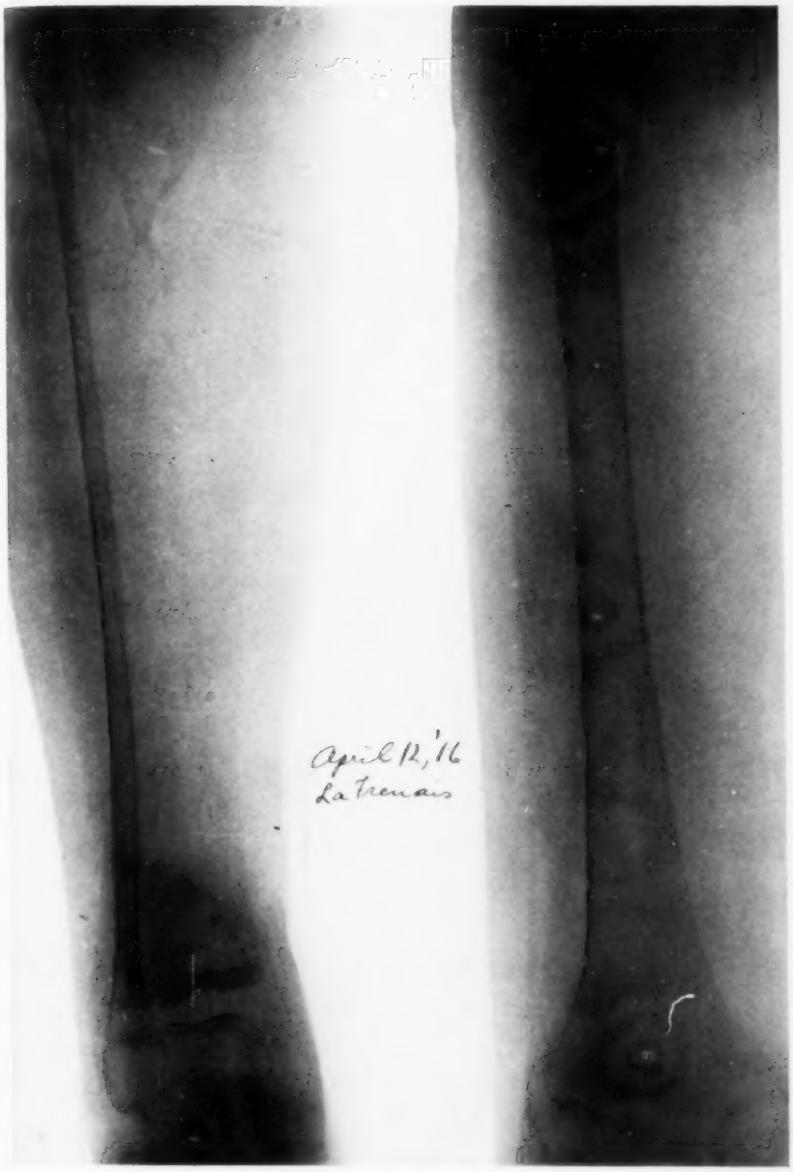

FIG. 1.—Case I. A. B., taken April 12, 1916, before operation for transplantation of the fibula (A-P view).

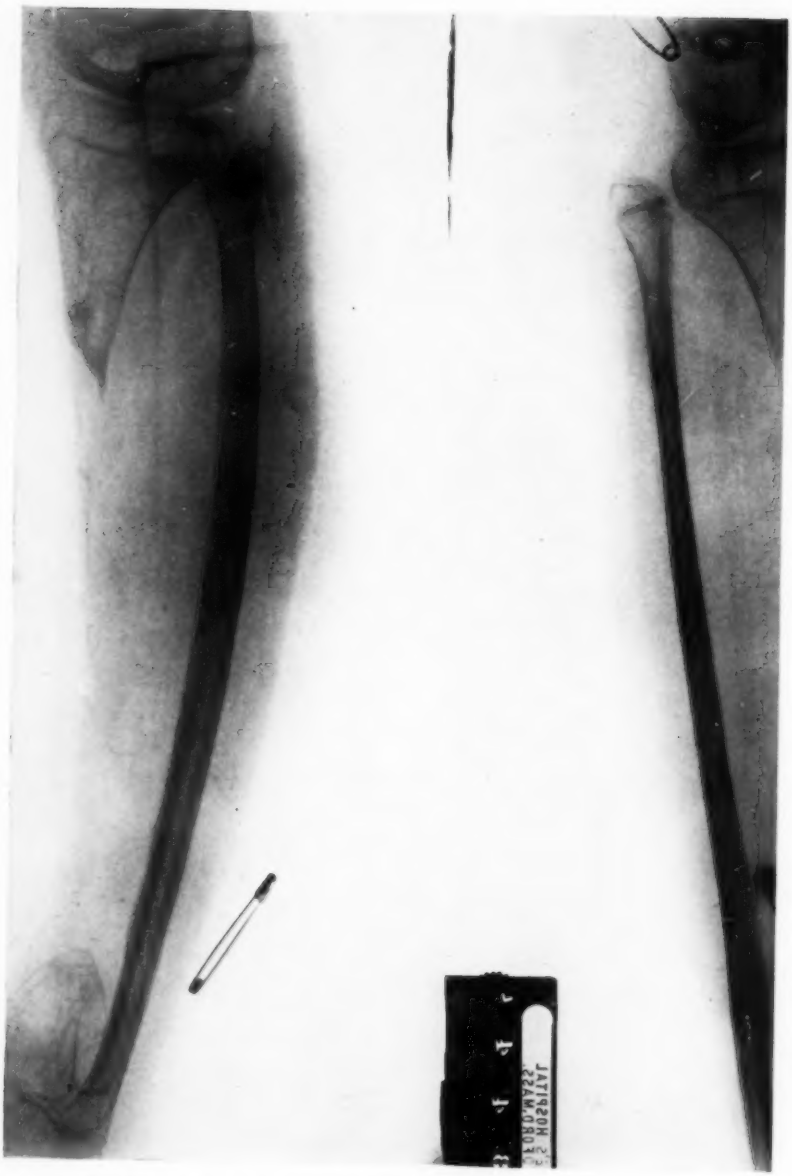

FIG. 2.—Case I. A. L., lateral view taken April 12, 1916, before transplantation of fibula.

FIG. 3.—Case IV, Moulton. Radiogram taken five months following lower transplantation and one week following upper transplantation.

FIG. 4.—Case I. A. L., post-operative radiogram, January, 1922.

FIG. 5.—Case II, N. Y.

FIG. 6.—Case II. N. Y. Post-operative radiogram, taken January, 1922.

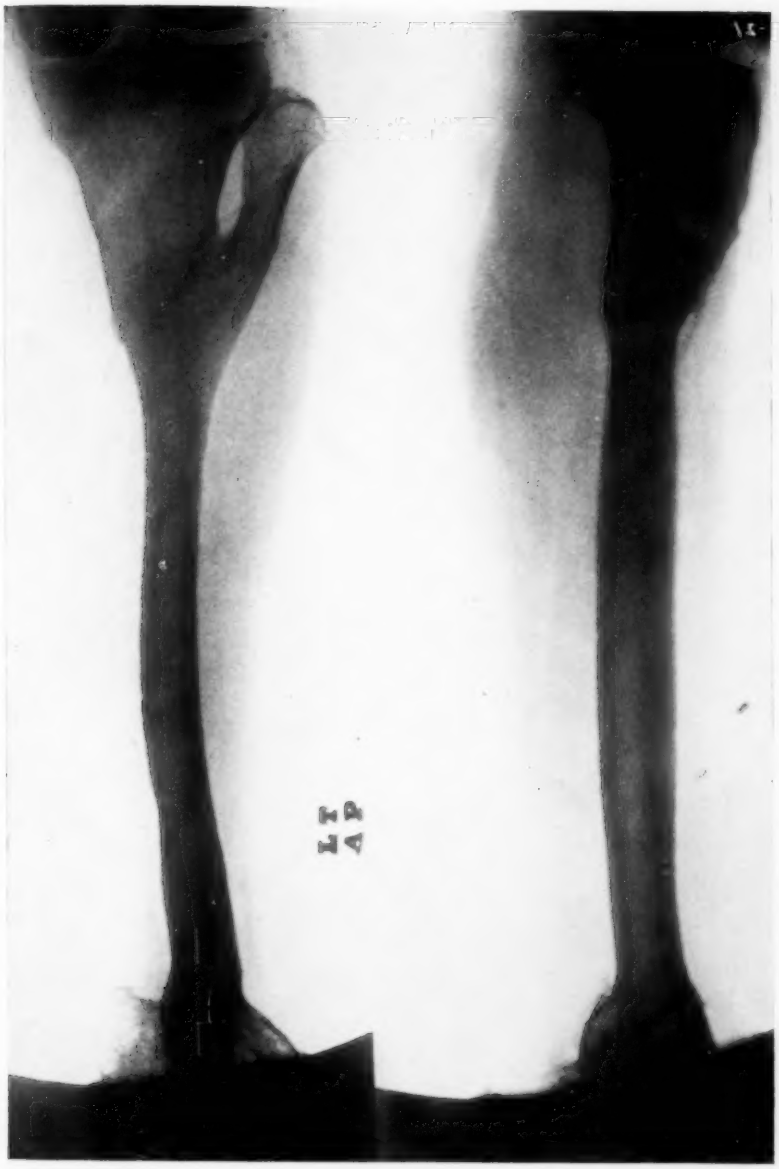

FIG. 7.—Case III. L. B. Radiogram taken twelve years after operation.

FIG. 8.—Case III. L. B. Radiogram taken twelve years after operation.

FIG. 9.—Case IV. C. W. M. Showing transplant of fibula into tibia.

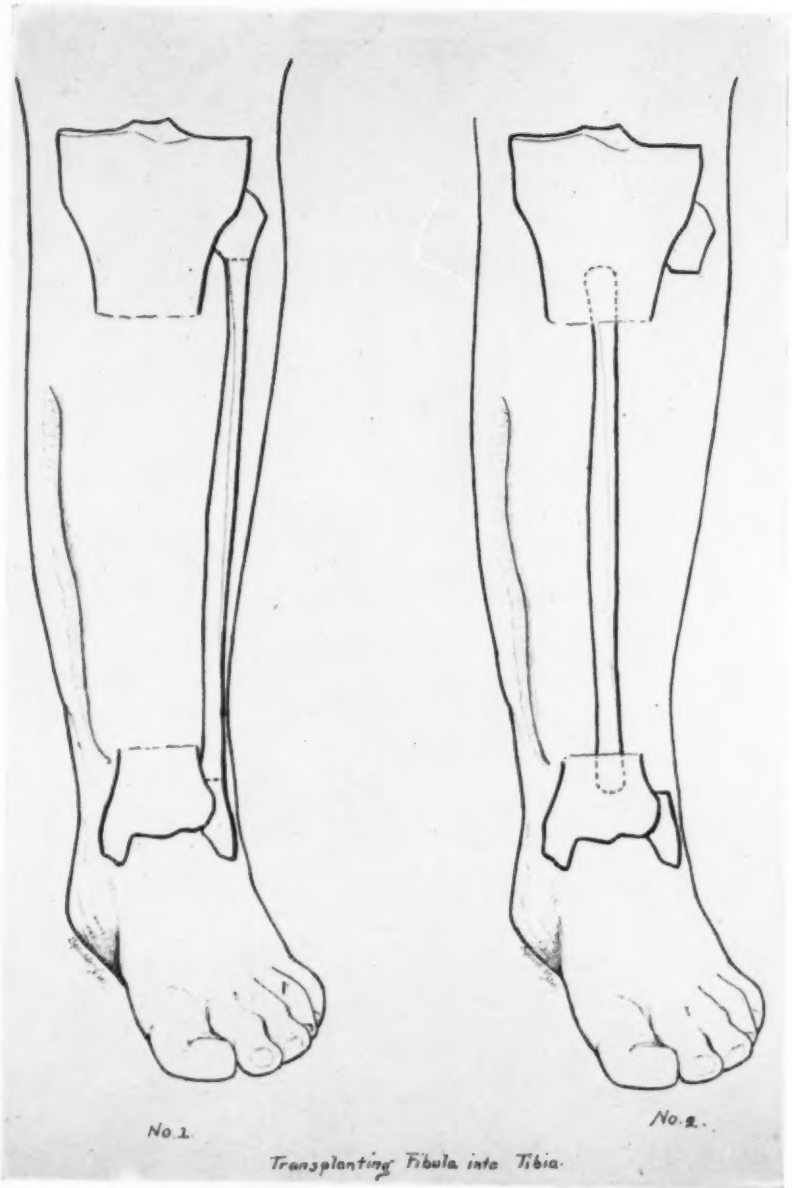

FIG. 10.—Diagrammatic sketch showing result of transplant.

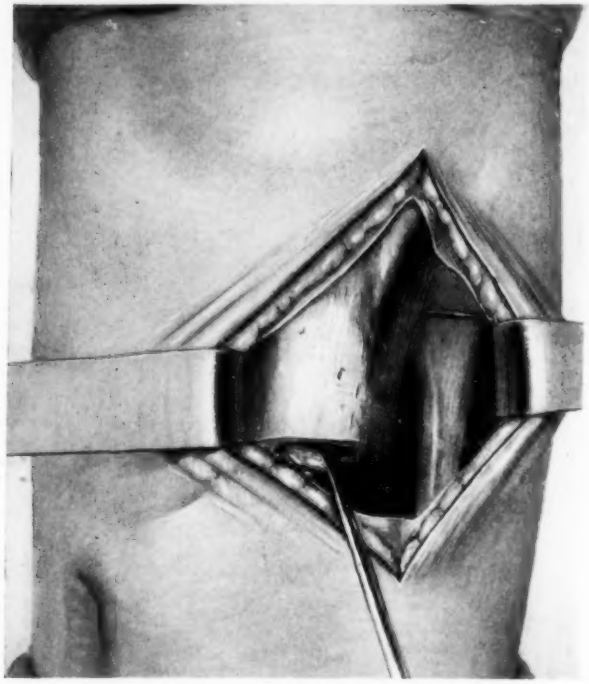

FIG. 11.—Drawing 1A, showing point of division of fibula preparatory to transplantation.

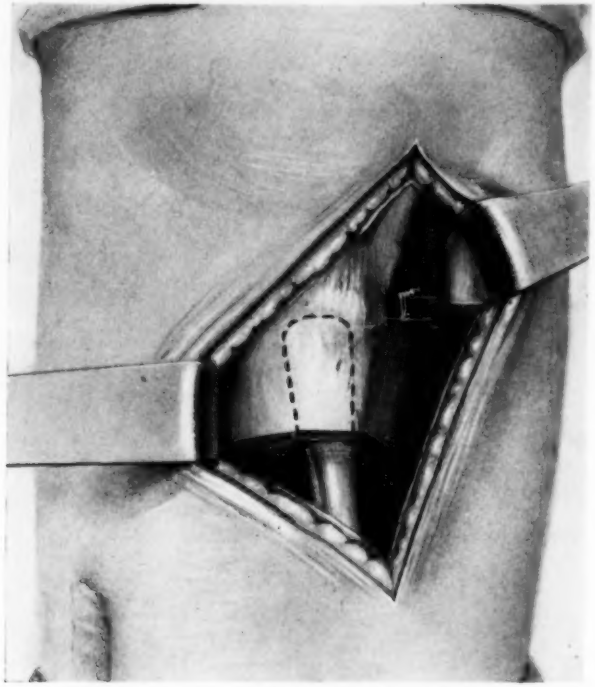

FIG. 12.—Drawing 1B. Transplantation in place.

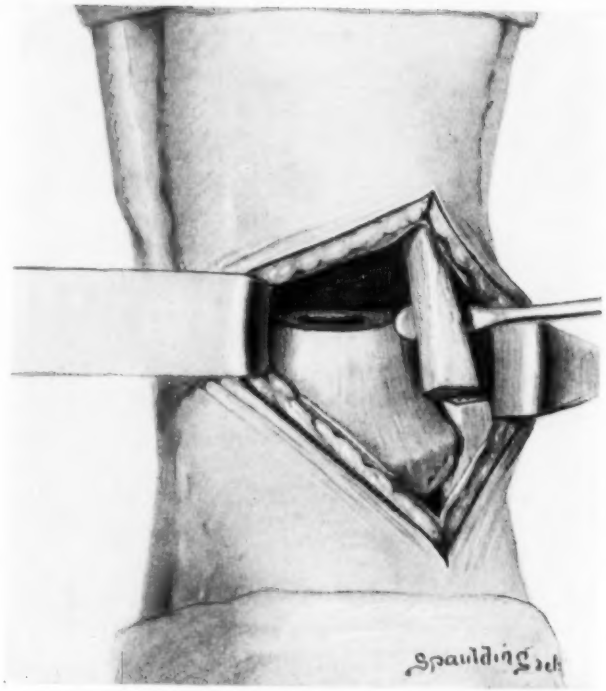

FIG. 13.—Drawing 2A, showing point of division of lower fibula preparatory to transplantation.

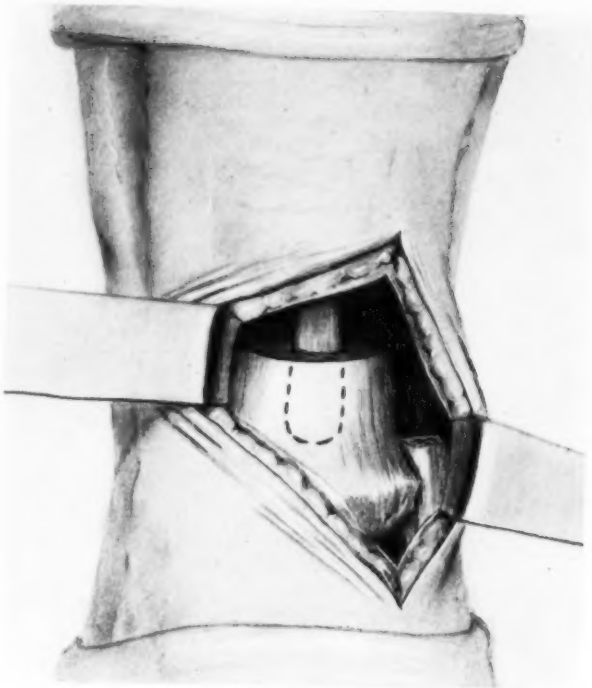

FIG. 14.—Drawing 2B, showing transplantation of lower fibula in place.

can be called satisfactory). The functional result is good. Both children can walk and run well without assistance, one without any noticeable limp and the other with only a slight one. From the surgical point of view the problem is how to secure the continuous growth in length of transplanted shaft and how thus to prevent the shortening of the limb, which occurred in both these, as in other recorded cases. In regard to this question of stunted growth, no doubt, much will depend on the extent to which the disease which destroys the original shaft also damages the osteogenetic capacity of the epiphysial cartilages, especially the one which exercises the greatest influence on the growth of the leg bones.

It was with the double object of restoring this capacity of bone formation to the damaged epiphysial cartilage and of counteracting the deformity of the limb caused by the unopposed growth of the fibula that Bond performed another operation on his third case. This case was a child aged four, who in 1903 developed a tuberculous focus in the upper epiphysis of the left tibia which partly destroyed the epiphysial growing line. After abscess formation and recovery a considerable deformity was left and the limb was carried inwards at a sharp angle below the knee by the unopposed growth of the fibula on its outer side. In November, 1905, the left fibula was divided just below the head of the bone and this with the epiphysis was removed. A V-shaped portion of bone was then removed from the inner side of the head of the deformed tibia in the situation of the normal epiphysial junction. The deformity was then corrected by forcibly straightening the shaft of the bone. The removed head of the fibula was now cut down to a V-shape and was inserted into the wedge-shaped gap in the head of the tibia so formed and the wound was closed. The grafted cartilage healed well in its new position. The child now walks fairly well. There is, however, still some shortening of the limb and some internal rotation of the foot, showing that the growth of the tibia has not kept pace with that in the opposite limb. The author's first two cases showed no increased growth; it made no attempt to take on new developments as long as it was connected with its own epiphyses, even though the tibia had been destroyed and it was exposed to new strains, but as soon as the shaft of this fibula became attached to tibial epiphyses, it began at once to assume a new outline and grow like the tibia. This fact suggests that it was the influence of osteoblasts from the tibial epiphyses which brought about the change and started the growth of the transplanted bone along tibial lines; it being a fact that in Bond's, as well as in other cases, the transplanted fibular shaft did develop into a bone of the size and shape of the tibia, shows that the failure to do so in some cases is not due primarily to the fact that the transplanted bone is "naturally" a smaller bone, but to the fact that it is not sufficiently taken over, or its growth is not sufficiently stimulated, by osteoblasts of tibial origin.

Torrance, Gaston[18]: Excision of the whole shaft of the tibia; replaced by transplanting the fibula. Surg., Gyn. and Obst., Feb., 1912, vol. xiv, pp. 184–186.

This case was a boy, six years of age, admitted to hospital May 15, 1908, with the history of having struck his right leg with a hammer over the middle of the tibia. An abscess formed at the point of injury, which was incised and curetted and healed up but reopened, and was operated again a few weeks later. Congenital syphilis was suspected, but no history could be elicited to confirm this. A considerable portion of the shaft had been chiseled out at different times, leaving a persistent sinus. When patient came under Torrance's care, about three months after admission, he was very much emaciated and ran a constant temperature. A skiagraph showed the tibia much enlarged and in an unhealthy condition.

Excision of the tibia was proposed. Under ether an incision was made along the anterior border of the tibia and the bone was sawed in two with a Gigli saw, leaving about an inch of bone at either end; the shaft was removed without any attempt being made to preserve the periosteum; the fibula was then sawed in two

at the upper end and transplanted to the stump of the tibia and was held in place by suturing the muscles up snugly around it. The leg was placed in a wire splint. A skiagraph, made a week later, showed the fibula to be in good position. His general condition began to improve at once. He was allowed to be up on crutches at the end of four weeks and was in good physical condition. Two months after operation two large ulcers developed near the point of the original injury and grew larger and deeper under local treatment.

He was put on potassium iodide and the dose rapidly increased to forty drops of the saturated solution, three times daily. He bore this treatment well and the ulcers healed rapidly. On questioning the father again he admitted that the child had contracted syphilis from kissing a relative at two years of age and had been treated for about a year. A skiagraph, made five months after operation, showed that the fibula had about doubled in size and that the union with the tibia was rounded off, resembling a joint "wiped" by a plumber. A few weeks later he was walking on the limb without a splint or crutch; the only difficulty he experienced was a slight tilting of the ankle. The lower end of the fibula was transplanted ten months after the first operation. He was allowed to walk about on crutches for two months and then lateral splints were applied and he was allowed to put some weight on the leg.

He was again seen in August, 1911, when a photograph and the last skiagraph was made. The muscles of the leg are well developed and there is no shortening; while the skiagraph shows some bowing of the shaft, the general lines of the leg are almost perfect and when standing with long stockings on it is not possible to tell which is the operated leg. He runs, jumps and plays with the other children and has perfect use of the leg.

T. W. Huntington[14]: Case of bone transference. Use of a segment of fibula to supply a defect in the tibia. Annals of Surgery, February, 1905, vol. xli, pp. 249–251.

Huntington's case illustrates the possibility of supplying a tibial defect amounting to absence of nearly the entire diaphysis by the appropriation of corresponding portion of the fibula. The early history of the case is that of an acute, infectious osteomyelitis of the left tibia. The patient, a boy of seven, entered the hospital in May, 1902. The trouble began a few days before. While at play he sustained a slight injury to the left leg just below the knee. Leg became swollen, tense and acutely tender. There was high temperature succeeding a chill. The attending physician made a small incision about three inches below the knee, from which, at time of admission, there flowed a small amount of clear yellow fluid. Tibia was extensively denuded and near the ankle there were two red fluctuating areas. An incision along the spine of the tibia from the tubercle to one inch above the ankle-joint revealed the fact that nearly the entire shaft was disintegrated. Pus oozed through several sinuses leading to the medullary cavity. On stripping the periosteum, the cortical portion of bone was readily scooped out with a curette, leaving a trough of periosteum. Having in mind the possibility of bone reproduction, the periosteum was stitched into a tube of small calibre. The wound was drained, partly closed and the leg laid upon a posterior splint. For three months there was gradual and satisfactory progress and the wound was fully healed. Six months later, despite an apparent effort on the part of nature to reproduce the tibia, there was still an interval of about five inches between the upper and lower fragments and progress here seemed to be practically suspended. The leg could not be extended upon the thigh, but hung loose, flail-like, and utterly useless. On January 27, 1903, Huntington finally determined to supply the defect by sawing the fibula at a point opposite the lower end of the upper tibial fragment and attaching it thereto. This was done without

difficulty and the divided end of the fibula was firmly planted in a cup-shaped depression in the tibia.

At this time the diameter of the fibula was about that of an ordinary lead-pencil. Union was tolerably slow but solidification was finally noted six months later. In September, 1903, the lad walked with the limb encased in two lateral splints as a support to the ankle-joint, there being a tendency for the foot to evert when the patient stands upon the affected member. Not satisfied, Huntington concluded to transfer the lower end of the fibula to the lower fragment of the tibia, which was done October 6, 1903. The wound healed kindly and on February 15, 1904, perfect bony union was secured. Since that time the patient has progressed admirably. The limb, though three-quarters of an inch short, has assumed the dimensions and in a general way the contour of the normal member. The transferred portion of the fibula shows that its diameter is now three-quarters of an inch, or practically the same as the opposite tibia. The lad joins in the ordinary sports of other boys and, despite the lateral deformity and slight shortening, he walks without support and with only the suggestion of a limp. In a similar case Huntington would insist upon the affected member being kept at rest until the second transposition could be effected; thereby avoiding the deformity, which is the only serious defect in this case. Considering the extensive destruction of the tibia which occurred before patient was seen by the author, he can conceive of no other method which would have offered a result so satisfactory as the one adopted.

J. S. Stone[15]: Partial loss of the tibia replaced by transfer of the fibula, with maintenance of malleoli of the ankle. ANNALS OF SURGERY, October, 1907, vol. xlvi, pp. 628–632.

The author's case was a boy five years old, who in June, 1904, had an acute dissecting periostitis beginning at the lower end of the right tibia and in six days stripping the bone nearly as far as the patellar tubercle. Owing to sloughing of the periosteum after removal of the shaft the tibia regenerated very imperfectly. Nine months after the onset of the trouble the bone had reformed for about one and one-quarter inches from the upper end. There was then a gap of about an inch. The fibula was normal. Thirteen months after the onset of the trouble he was admitted for operation. Since ten weeks after the trouble began he had been going about with a plaster bandage and Thomas knee-splint. The attachment of the upper end of the fibula had become loose so that the head of the bone could be shoved upward slightly and the foot moved inward for about two and one-half inches. There was marked shortening of the leg and the foot was a little smaller than on the sound side. The fibula had become somewhat hypertrophied, particularly at the middle of the shaft. All wounds were healed.

It was decided to transfer the fibula into the gap in the tibia. The upper end was transferred first. A vertical incision about three inches long was made directly over the lower end of the upper sound portion of the tibia. The cut was made directly through the periosteum which was separated on the fibular side for a vertical distance of about two inches. In order to reach the fibula more readily a second incision of one and one-half inches long was made directly down onto the bone on the outside of the leg. At about two inches from the upper end the fibula was then cut across with a chain saw. The upper end of the lower fragment was then inserted into a mortise cut in the tibia. The periosteum was reflected from that side of the fibula which rested in the mortise. The reflected periosteum of tibia and fibula were then sutured together with chromic catgut to maintain close apposition and the reflected periosteum of the tibia was further sutured as a cuff around the upper end of the fibula to hold it more securely in position. The incisions were closed with drainage. A sterile dressing and plaster bandage were applied. The boy was readmitted to the hospital five months after-

wards. The union between the upper end of the tibia and the fibula had become absolutely solid and the shaft of the fibula had materially increased in thickness. Five and a half months after the first operation a longitudinal incision was made anteriorly over the outer part of the lower end of the tibia. The bone was exposed. By careful dissection the lower end of the fibula was then exposed through the same incision and split horizontally with a chisel for a distance nearly four inches. A small pocket was cut in the cartilage covering the end of the tibial epiphysis just large enough to receive the inner half of the fibula.

The inner half of the fibula was then sprung into its new position in the tibia. Closure was made without drainage. A plaster bandage from the toes to the thigh completed the dressing. Three months later plaster was removed. A small granulating spot was found at the lower end of incision. Bony union was solid. Five days later a small piece of necrotic bone about three-quarters inch long was discharged. After this the skin healed solidly. A month later the boy began to walk on his leg, and ever since has used it without restraint. The problem presented in this case was the restoration to usefulness of a leg in which the fibula was sound, the upper end of the fibula was sound and in which the lower epiphysis of the tibia remained, but without any shaft for a distance of nearly five inches. The continued increase in the size of the transferred bone is most striking and corresponded in amount with the freedom of use which was allowed. In any similar case more prompt transfer of the bone would seem advisable. The length of time allowed between the steps of the operation might also have been shortened.

A. Keith[16]: Fibula transplantation to replace the necrosed shaft of the tibia. Menders of the Maimed. London, 1919, p. 273.

Keith states that the most instructive examples of bone transplantation are those in which the fibula has been used to replace the necrosed shaft of the tibia. The case he wishes to call attention to is that of Bond (*Brit. J. Surg.*, 1914, vol. i, p. 610), who operated in May, 1905. He also cites Professor Huntington as having carried out the first successful substitution of fibula for tibia, publishing an account of it in 1905 (ANNALS OF SURGERY, 1905, vol. xli, p. 249). The same problem had presented itself to two men situated on opposite sides of the earth and both had adopted the same method of solving it.

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[15] J. S. Stone: ANNALS OF SURGERY, October, 1907, vol. xlvi, pp. 628–632.
[16] A. Keith: Menders of the Maimed. London, 1919, p. 273.

FIBROUS TUMORS OF THE FOOT

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A glance at text-books and through the literature will show that tumors of the foot are very infrequently met with. Non-malignant neoplasms affecting the plantar part of the foot are especially rare; such tumors as occur are usually of a malignant type. The following two cases, therefore, should possess certain interest not alone from the rarity of the situation, but also from the non-malignant nature of the growths.

Case I.—*Fibroma of Left Internal Malleolus* (observed and operated in 1914).—A woman of forty years. Personal and family history negative as regards malignancy. Seven years previous to the present examination the patient received an injury on the internal malleolus of the left ankle. About three years later appearance of a new growth was noted which continued slowly to increase in size. Pain was slight except on deep pressure. The integument covering the tumor was eczematous.

Under gas-ether anæsthesia the growth was removed and the site of its attachment thoroughly curetted and cauterized. Wound was left open for healing by granulation. Two weeks later a secondary operation was performed for the purpose of transplanting skin to repair the defect, which now showed healthy granulation. Skin was transplanted from the patient's daughter, healing perfectly.

Photographs of this case taken while the tumor was present and of the same region after removal of the neoplasm fully show the results. (See Figs. 1 and 2.) Microscopically the tumor was a myxo-fibroma. (For histological examination of removed tumor, see end of Case II.)

Case II.—*Fibroma of Right Plantar Fascia.*—Mrs. B. E., hospital number 6827, admitted June 5, 1920. White, American, female, married, aged thirty-six, housewife. Family history negative as regards malignancy, tuberculosis, etc. Personal history negative. Menstrual history normal. No pregnancies. Previous diseases: When a child had measles and mumps.

Onset of present trouble: Patient discovered a small tumor on the sole of the right foot three years ago. It was painful, and was surgically removed.

Clinical history: When about fourteen years of age the patient ran a nail into the sole of the right foot. Ten years later a tumor began to form in this region. The growth continued, gradually increasing in size until September, 1917, when it was surgically removed. After operation soreness continued, and about six months later it was noticed that the tumor was again growing at the site of the former operation, gradually increasing in size to its present dimensions.

Physical examination: Head, neck, chest, etc., negative. Right foot: Large mass of new growth on the plantar surface of the sole of the foot. Integument unbroken (see Figs. 3 and 4). Painful to the touch (moderately), immobile. Inguinal glands and adjacent glandular structures free.

Operation, June 6, 1920, gas-ether anæsthesia. Incision around the tumor and blunt dissection of the tumor mass from the plantar fascia, to which the growth was firmly attached and apparently springing from that structure. After the bulk

of the growth was removed the fascia was curetted and cauterized. Wound left to heal by granulation.

A secondary operation was done fifteen days later for the closure of the wound by skin grafting. A section of skin corresponding in size to the defect of the sole of the foot was taken from the right supra-iliac region of the patient's husband and the defect covered therewith. Recovery uneventful.

Pathological report: Gross pathology: (see Figs. 5 and 6), a tumor, size eight cm. long, six and five-tenths cm. high, four cm. deep. Removed by operation from the plantar fascia. Gross specimen covered by epithelial tissue, color of skin. Consistence firm. On cross-section the gross specimen is divided into one large and one smaller mass.

Microscopical examination (Cases I and II): The gross histology of the tumors removed in both instances can best be judged by studying the appended photographs. Histologically the tumor masses in both cases consisted of connective-tissue cells in all stages of metamorphosis. Some were spheroidal, some spindle-shaped and some of distinctly embryonal type; some were running a parallel course while others showed a concentric disposition. Here and there soft spaces proved microscopically to be the soft variety of fibrous tissue. Blood-vessels were few; within the softer areas the vessels were more abundant. No karyokinesis; no malignant elements.

Microscopic diagnosis: Fibroma of the plantar fascia in one case and myxofibroma in the other. In the case of tumor of the plantar fascia there was every reason to suspect malignancy, from the clinical point of view, yet microscopically such was not found to be the case. Hence all precautions were observed in clearing away every vestige of the tumor tissue from the normal generous allowance for the overlying integument, and thorough cauterization with the actual cautery.

A review of the literature concerning tumors of the feet shows that fibrous tumors are extremely rare. Tumors of the sarcomatous type are those which more usually occur. A number of malignant melanotic tumors have been observed by Hertzler and Gibson [1] and by Stevenson.[2] These tumors have been variously described as chromato-phoroma, melanoma, and melano-sarcoma. Hertzler and Gibson prefer to term them melanoblastomas. They are ulcerous or fungoid lesions more usually on the plantar than the dorsal surface of the foot with a tendency to recurrence if excised; they metastasize by the lymph route and are freely melanotic. They originate from the chromatophores, the stimulating factor being usually some trauma. The authors preferred to think it unwarranted to class these tumors with the sarcomata. They report eleven cases and mention several similar tumors described in the literature. The majority gave a history of trauma, this generally being a puncture from a nail in the shoe or some similar injury. Stevenson reported fifteen similar malignant melanomata occurring either on the heel or sole of the foot in natives of Bombay, India. Nearly all gave a traumatic history. In the two tumors referred to in the present report nothing was found in the histological examination which would connect them with the melanotic type.

Lipomatous tumors of the plantar surface have been reported by Tubby,[3] Bland-Sutton,[4] Du Castel,[5] Casali,[6] and Chevalier.[7] Both of Tubby's cases gave a history of trauma. Bland-Sutton's case was a fibrolipoma.

FIG. 1.—Tumor of foot. (See Case I.) Fibroma left internal malleolus.

FIG. 2.—Same. Three months after surgical removal.

FIG. 3.—Fibroma of right plantar fascia. (See Case II.)

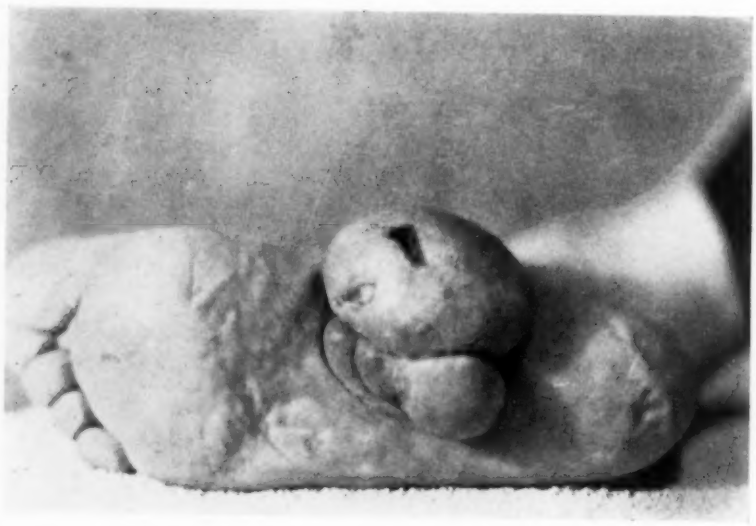

FIG. 4.—Fibroma of right plantar fascia. (See Case II.)

FIG. 5.—Same. Gross appearance of tumors after enucleation.

FIG. 6.—Same. Gross appearance of tumors after enucleation.

FIG. 7.—Same. Appearance of foot after transplantation of skin into bed of tumor.

FIG. 8.—Appearance of foot eight weeks after operation.

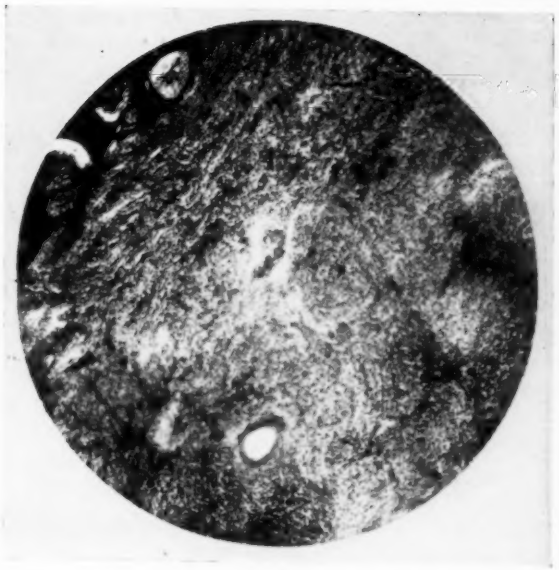

FIG. 9.—Microphotograph (low power) Case II.

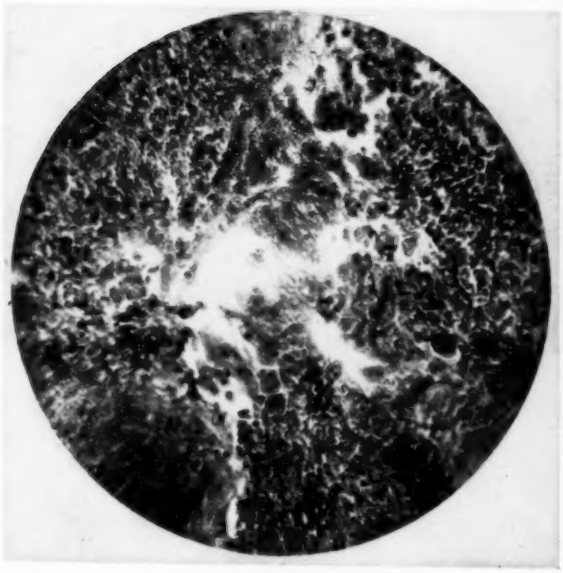

FIG. 10.—Same. High power magnification.

In Bland-Sutton's case the specimen was found in the Museum of the Royal College of Surgeons, London. The tumor was thirty years old; on microscopical examination by Bland-Sutton he found that the tumor mass consisted of a fibrous network, the spaces between the meshes consisting wholly of fat. It may, therefore, be described as a fibro-fatty tumor. Bland-Sutton calls it a fibro-lipoma of the plantar fascia; it occupied the whole sole of the foot and amputation had been done.

Du Castel's case is also stated by him to be a lipomatous tumor with fibrous transformation. There was no histological examination. Casali reported a subfascial lipoma. The subject of lipomata of the sole of the foot was reported upon by Kleinnecht [27] in 1898. He collected seventeen cases from the literature.

Sarcomata and epitheliomata of the sole of the foot have been reported by Stevenson (besides the malignant melanomata already referred to), Heurtaux,[8] Jessett,[9] Nasse,[10] Steiner,[11] Canbet,[12] Morestin,[13] Graham Little,[14] Marchand,[15] Gaucher and Abrami,[16] and others. Heurtaux's case was sarcoma of the plantar fascia.

Mermet [17] removed an alveolar sarcoma from the external malleolus. Duvergey [18] described a case of botryomycosis on the plantar surface of the foot following a traumatism. It has been confused with rodent ulcer.

Nævi have been reported by Latronche [19] and Landois.[20]

Latronche's case was one of multiple nævi on the plantar and dorsal faces of the foot and in the leg. Landois' case was in the dorsum pedis.

Fibrous tumors of the foot, similar more or less to my second case, have been reported by Houel,[21] Davies-Colley,[22] Duret,[23] Routier,[24] and Penières.[25] Houel's case is described as a cystic tumor the size of a hen egg; it was twenty years old, of unstated origin, situated on the dorsum pedis and surgically removed. Microscopically it was a fibro-plastic tumor. In Davies-Colley's case the patient fell and suffered a patellar fracture thirteen months previously, since which time the sole of the foot was tender and swollen. The removed tumor proved to be a fibrous thickening of the plantar fascia without any capsule. Davies-Colley thinks the cause was a laceration or injury at time of the fall. Duret's case was congenital. The tumor occupied all the sole and edges of the left foot; it was hard and ligneous but not painful. The connectival neoformation predominated in the middle layer of the derma; all the thickening appeared to be at the expense of this zone; the epidermis took only an accessory part. The tumor was removed in blocks by abrasion. The histological diagnosis was an elephantiasic diffuse fibroma. Routier's patient gave a history of a fall on the left foot twenty years before. He was told there was neither fracture nor sprain. Tumefaction appeared by degrees on the concavity of the plantar vault of the foot. A tumor of the plantar aponeurosis size six cms. x four cms. was resected and on histological examination proved to be a very vascular fibroma. Penière's case is described as a fibroma of the annular ligament of the tarsus, but as the original article is not available, I regret I can give no further particulars.

Without being exhaustive, the fairly general survey of the literature which has been made therefore shows but very few cases of fibrous tumors involving the plantar fascia.

With regard to the etiology of these cases it is to be observed that trauma is common. In the case of tumors of a sarcomatous epithelial or melanotic type the trauma is more usually a punctured wound from a nail or other pointed object. In the fibrous tumor the trauma is more frequently of a

diffuse type. However, in my second case the history is that of a nail penetrating the foot.

Resection of the tumor mass appears to have been the surgical treatment generally adopted. Steiner [11] obtained good results from excision and skin-grafts, and Mauclaire,[26] in a case of rodent ulcers of the foot, also obtained a good result from excision followed by Italian graft.

> The necessity for careful investigation of any suspicious looking swelling of the foot is apparent from a case of sarcoma of the foot reported in the United States Medical Naval Bulletin for October, 1920. This case was diagnosed as abscess of the foot. A small incision was made for the purpose of draining the supposed abscess but no pus was found. Three days later the patient was admitted to the hospital. At this time a small piece of tissue was removed for diagnostic purposes and the wound cauterized. There was beginning cellulitis, and a temperature of 103.8. On the following day there was swelling of the foot and leg, accompanied by marked inflammation. The inguinal and saphenous glands were enlarged and painful and symptoms of phlebitis were developing. Microscopical diagnosis, round-cell sarcoma. Amputation was refused and the patient continued to show signs of toxæmia and chest symptoms. A frank lobar pneumonia developed, which gradually cleared up. In the meantime the inguinal and saphenous glands broke down, requiring incision and drainage. The tumor grew rapidly, metastatic new growths appeared in the popliteal space, lumbar region, abdomen and right lung. Death resulted in a little less than three months after the patient was admitted to the hospital.

Two very significant and valuable points are suggested by this report; that of the necessity of thorough eradication of any suspicious neoplasm with thorough cauterization to prevent its spread, and that an acute pyogenic infection does not protect from or inhibit the malignant progress when the growth is of that type.

DESCRIPTION OF PLATES

Fig. 1. Tumor of foot (see Case I). Fibroma left internal malleolus.
Fig. 2. Same. Three months after surgical removal.
Figs. 3 and 4. Fibroma of right plantar fascia (see Case II).
Figs. 5 and 6. Same. Gross appearance of tumors after enucleation.
Fig. 7. Same. Appearance of foot after transplantation of skin into bed of tumor.
Fig. 8. Appearance of foot eight weeks after operation.
Fig. 9. Microphotograph (low power), Case No. II.
Fig. 10. Same. High-power magnification.

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THE SURGICAL TREATMENT OF UTERINE PROLAPSE

END RESULT IN THIRTY CASES

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AND

John M. Hundley, Jr., M.D.

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The number of different operations proposed for the cure of procidentia would indicate that no agreement has been reached as to which is the best procedure in these cases. After a trial of several different types of operations, the Watkins' has given better results than any other we have used. Our object in making this report is (1) to record our end results, and (2) to emphasize certain steps in the operation which we believe are important to obtain satisfactory results. On going over the records for the last fifteen years, forty-five cases of procidentia with fairly adequate histories were obtained. A number of other histories were found which could not be used because of insufficient data. Of the forty-five cases the end results were ascertained in thirty. Twenty-nine were cured, and one was a partial failure. The reason for this failure will be referred to later. We failed to trace fifteen. Those interested in the historical account of the developmental phases of this type of operation are referred to the article by Watkins in *Surgery, Gynecology and Obstetrics*, 1906, vol. xi, p. 659, entitled "The Treatment of Cases of Extensive Cystocele and Uterine Prolapse."

Technic of Operation (Fig. 1).—This picture shows outline of the incision in the anterior vaginal wall, and half-way around the cervix. The incision extends within half inch of the meatus urinarius.

Fig. 2. The bladder is now being separated from the vaginal walls and cervix. Care should be taken that the separation is begun in the proper plane. If this is done the tissues separate easily and injury to the bladder is avoided.

Fig. 3. The bladder is now retracted, when the thin fold of utero-vesical peritoneum comes into view. This fold is picked up with forceps and incised. The wound may be enlarged by stretching with two fingers if too small to allow the free delivery of the body of the uterus.

Fig. 4. After the body of the uterus is well delivered and in anteflexion two chromic catgut sutures are passed through the tissues near the pubic arch, next through the posterior wall of the uterus near the fundus, and then through the tissues near the pubic arch of the opposite side. The sutures are now tied, and the fundus is replaced in the pelvis.

Fig. 5. The broad ligaments are now brought forward and sutured in front of the cervix. Watkins, in *Surgery, Gynecology and Obstetrics*, 1906, advocated this procedure in extreme cases only. We adopted this suggestion

in 1907, and have used it since in all of our cases, and believe it essential to insure a permanent result. To avoid dead space, and to strengthen the anterior vaginal wall, we suture the musculature and fascia of the vagina in front of the cervix with interrupted sutures of catgut. The cervix is now amputated, and the redundant vaginal flaps excised.

Fig. 6 shows the wound in the anterior vaginal wall closed, and the cervix covered with mucosa. In doing this operation we have in mind that prolapsus uteri is a hernia, and that the same principles should obtain here as are used in operating on hernias elsewhere.

Fig. 7. A perineorrhaphy is now done. The operation depicted in the drawings is a composite one, made up of points gathered from various operators. We discarded the Emmet operation some years ago for the one we are now doing, which is of the flap-splitting type. The picture shows the outline of the incision at the mucocutaneous junction.

Fig. 8. After this incision is made the vaginal wall is separated from the rectum high up on the crest of the rectocele. This accomplished, the levators are brought into reach by forcibly stretching the wound from side to side.

Fig. 9. This picture shows the levator ani muscles brought to the midline, and the sutures placed.

Fig. 10. The sutures in the levators are shown tied, and the wound is ready to be closed, as shown by the sutures in the picture. Where there is a complete eversion of the rectovaginal septum the vaginal wall must be separated from the rectum nearly up to the cervix, and the redundant flaps excised. These procedures narrow the vaginal canal to approximately its normal calibre. An ordinary perineorrhaphy will not effect a cure in the extreme cases.

Fig. 11. This picture, taken from Watkins' article, *Surgery, Gynecology and Obstetrics,* 1906, shows the position of the uterus in the completed operation.

In addition to the above procedure, in Case XIV, a laparotomy was done for the purpose of shortening the uterosacral ligaments and anchoring the upper end of the vagina. This was done by passing two rows of quilting sutures from side to side in Douglas' pouch, and then suturing it to the posterior wall of the cervix, after having first shortened the uterosacral ligaments. This was done in 1919. The senior writer thought this was original with him until reviewing the literature on the subject, when he found that D. F. Jones had had the same experience in thinking that he had discovered something new. Jones on reviewing the literature discovered, as he says, in the *Boston Medical and Surgical Journal,* 1916, clxxv, 623: "For about a year before Moschcowitz's article came out in 1912 I thought that I had made a discovery. In his paper Moschcowitz intimates that he thought he was getting out something original, but found that Waldeyer, Ludloff, Zuckerkandl, and others had described very accurately the pathological anat-

omy of the condition, and that Bordenheuer in 1902, and Quénu and Duval in 1909, had published operations very similar to the one he advocated." The reason we adopted this method was because the result in Case IV, alluded to previously, was not a success. In this case the rectocele recurred. With this experience in mind, when consulted by Case XIV, which was of a like type, we decided to anchor the upper end of the vagina, having in mind that fixation of the upper end of the vagina would prevent recurrence of the rectocele. At the time that this operation was done we did not appreciate the influence a deep cul-de-sac exercised in the production of prolapse of the vaginal walls. Only after reading the explanation of Jones did we fully appreciate the part played by the deep cul-de-sac in these cases. In the article above referred to Jones states that the closure of the cul-de-sac allows the weight of the intestines and the intra-abdominal impact to fall on the uterus, bladder, and anterior abdominal wall, while the deep cul-de-sac allows this impact and weight of the intestines to fall on the anterior rectal wall, or posterior vaginal wall, thus exerting a downward pull on the uterus which helps to increase the prolapse. A congenitally deep cul-de-sac and faulty development of the pelvic fasciæ is thought by many to be the cause of procidentia in virgins.

REPORT OF CASES

This type of operation is applicable in women who have passed or are approaching the menopause. It should not be done on women in the child-bearing period unless the tubes are resected.

In this series twenty patients had passed the menopause, and five were approaching it; their ages varying from thirty-eight to fifty. The ages of the five remaining cases were from thirty-one to thirty-seven. The reasons for doing an interposition operation on this group—thirty-one to thirty-seven years of age—were as follows: A suspension and perineorrhaphy had been done in Case XVIII some time previously with return of the prolapse. There was a complete rolling out of the vagina and prolapse of the uterus in Cases VII and XIII, and it was thought that a good result could only be obtained by this type of operation. The two remaining cases showed extensive relaxation and procidentia. Both were hard-working women, and it was thought that a satisfactory result was more important to them than bearing more children. Of the thirty cases herewith reported, twenty-eight were married and two single. Twenty-seven had had children, the number varying from one to nine. Two cases, IX and XXIX, were single and had had no children. One patient, Case VIII, was married, but had never been pregnant. She was a dwarf with a kyphosis and lateral scoliosis. One of the objections to the interposition operation offered by some men is the resulting cystitis which occurs in a large proportion of their cases. We have not had this complication. Thirteen of the patients voided after the operation, and of the remaining seventeen the majority had to be catheterized over a period of only one to four days.

FIG. 1.—Incision in anterior vaginal wall is here shown.

FIG. 2.—The bladder being separated from vaginal walls and cervix.

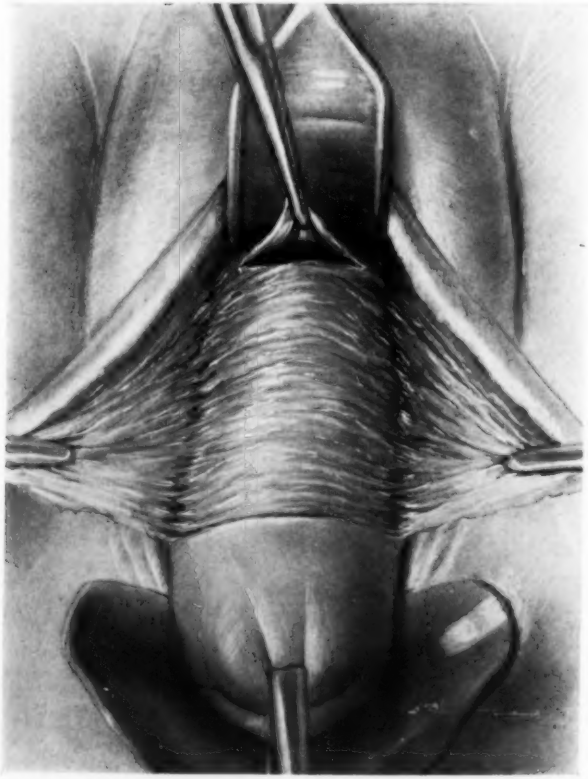

FIG. 3.—Opening in uterovesical peritoneum.

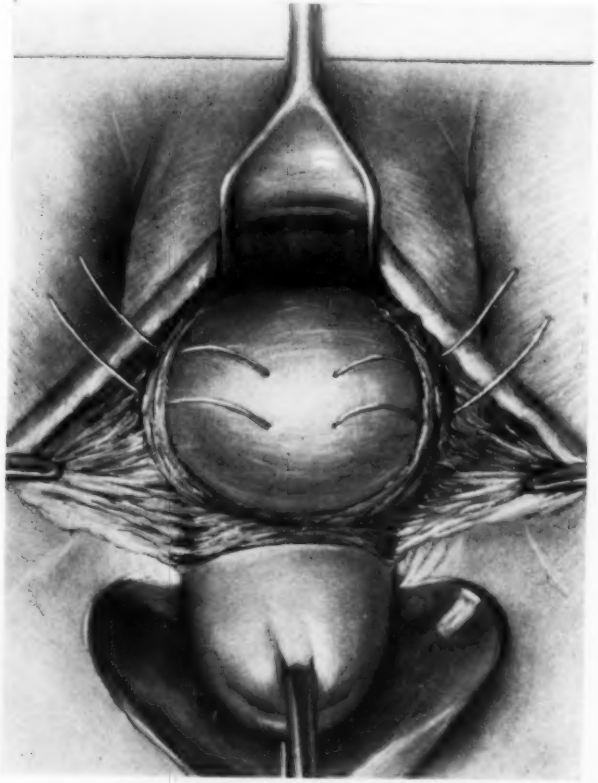

FIG. 4.—Fundus anteflexed with sutures inserted.

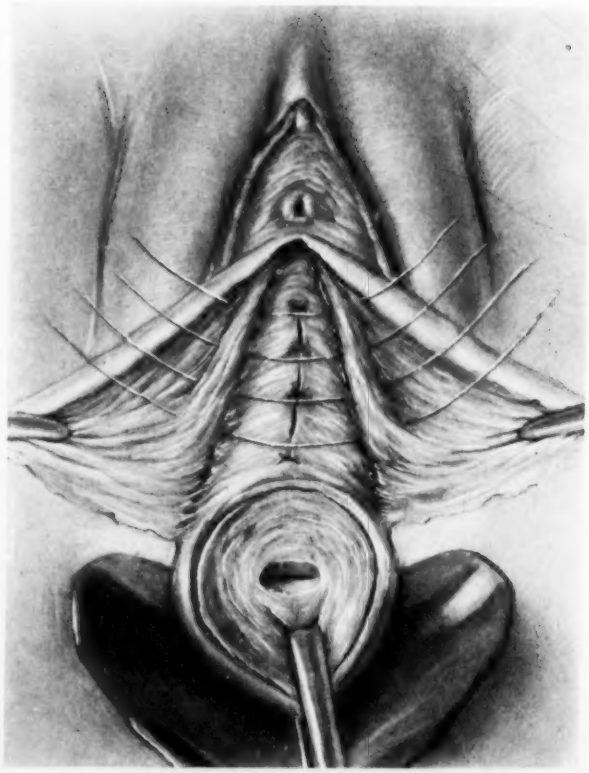

FIG. 5.—Broad ligaments sutured in front of cervix: cervix amputated. Vaginal musculature and fascia sutured in separate layer.

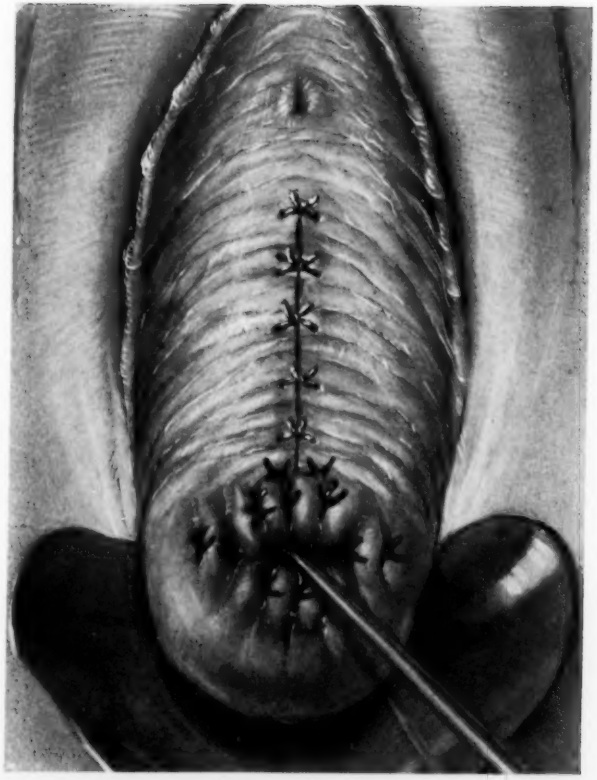

FIG. 6.—Wound in anterior vaginal wall closed and cervix covered with mucosa.

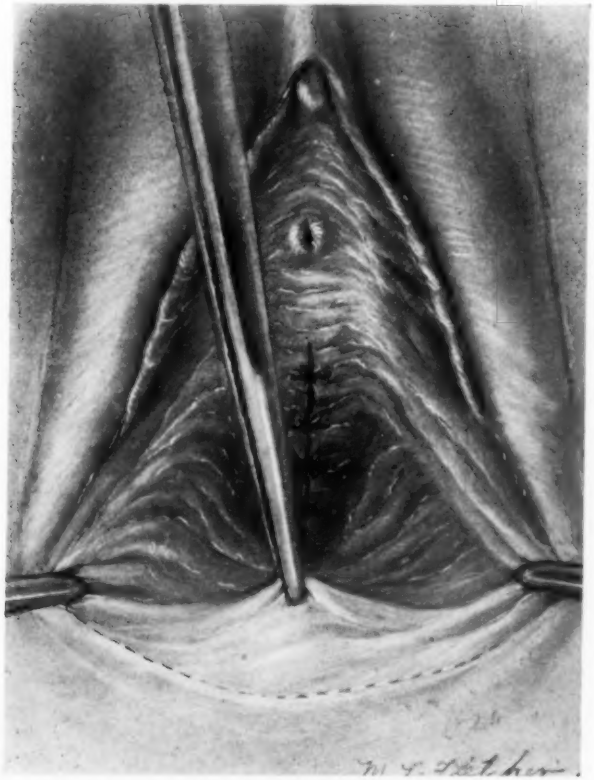

FIG. 7.—Outline of incision at mucocutaneous junction.

FIG. 8.—Vaginal wall being separated from rectocele.

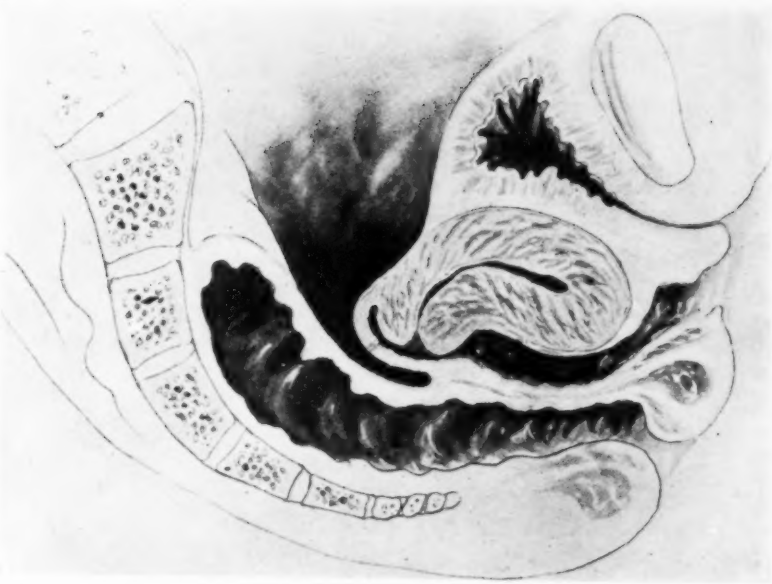

FIG. 11.—Sagital section showing uterus in its new position.

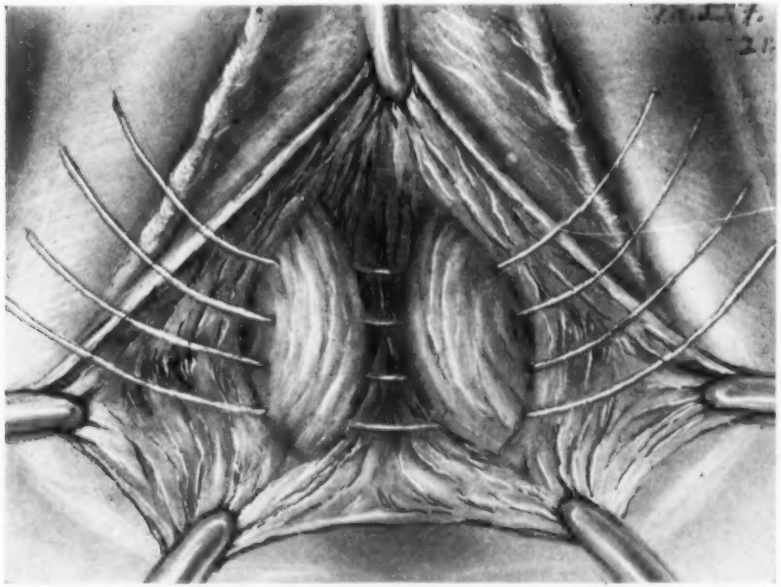

FIG. 9.—Levator ani muscles brought to midline, and sutures placed.

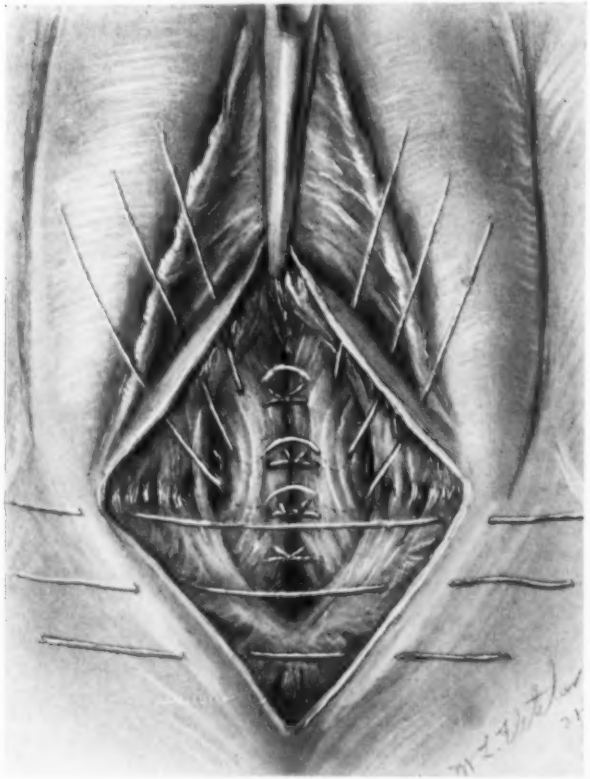

FIG. 10.—The V-shaped sutures are shown, and wound is ready for closure.

Case number twenty-four could never void while in bed, and patient number eight before operation complained of frequency and dysuria, and following operation her symptoms became more severe. Her bladder was instilled with a solution of nitrate of silver, one to a thousand, daily, which gave great relief. Several of the patients, seven, fifteen and twenty-two, complained of frequent desire with difficulty in starting the flow, and having to replace the uterus before it could be accomplished, voided soon after the operation. This demonstrates very clearly one of the objects of the operation, that is, the elevation of the base of the bladder by the fundus of the uterus. It is thought by some that separating the bladder from the cervix and vaginal walls causes changes in the bladder mucusa which lead to chronic cystitis. This has not been our experience. Cystoscopic examination has been made on several patients following operation and no evidence of cystitis could be made out. The base of the bladder could be seen pushed up by the body of the uterus. Average duration of stay in the hospital following operation was about eighteen days; one patient, on account of infection in perineum, was confined to the hospital forty-five days. She finally made a satisfactory recovery. A complete cure was obtained in all of our cases except one. This case, number four, which was a partial failure, might have been cured if the cul-de-sac had been treated as described by Jones, and then anchored to the posterior wall of the cervix. The outstanding symptoms were found to be prolapsus, leucorrhœa, not infrequently bloody, due to irritative ulceration of the cervix; backache and headache; bearing-down feeling in the pelvis; constipation and hemorrhoids. Frequency, dysuria and difficulty in starting the flow were prominent symptoms. All patients on pelvic examination showed cystocele, rectocele and procidentia. The period of time which has elapsed since operation is as follows: 1907–1911, eight cases; 1911–1915, seven cases; 1915–1919, six cases; 1919–1921, nine cases.

CONCLUSIONS

1. The interposition operation gives better results than any other operation we have used in the extreme cases of uterine prolapse.

2. Of the thirty cases there has been no return of the procidentia. In one the rectocele returned. She reported that she was sufficiently comfortable, and did not wish to be operated on again.

3. A small percentage of the patients complain of some bearing down and discomfort in the bladder after doing a hard day's work.

4. In cases with marked eversion of the vaginal walls, associated with complete uterine prolapse, a cure can be effected by plicating the cul-de-sac of Douglas, and anchoring it to the posterior wall of the cervix, together with shortening of the uterosacral ligaments.

NEW MECHANICS IN BONE INJURIES

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From the remote past, surgeons have recognized that the indications in fractured long bones are to correct the deformity by traction and provide a fixation device to retain the injured member in its normal position.

Traction has followed two general methods. In the one by manual manipulation and possibly mechanical appliances reduction has been attempted and then fixation apparatus has been applied. In the other, the limb has been placed as nearly as possible in normal alignment and traction has been exercised by cord pulley and weights applied in such a way as to give the direction of pull indicated.

Many fractures are of such a type that by the intelligent application of manual manipulation they can be replaced perfectly and retained in position by a simple splint.

There have been various mechanical devices to increase traction power. The most modern are several models of tables all designed on the one principle of fixing the part above the fracture and by cranked screws exercising traction on the distal part of the fracture. Usually in this latter method plaster-of-Paris is applied while the limb is maintained in this extended position. According to this plan of treatment the surgeon uses his judgment as to whether he has secured good alignment and replacement. Should the X-ray prove this to be not the case, he either decides that it is as good as he can secure or he makes a second attempt. He must then remove his cast or other dressing and working from the beginning again endeavor to secure a better position. Fluoroscopy has been used but is dangerous and most often impracticable. The judgment of the best is never infallible.

Traction by pulleys and weights is much more uncertain. In practice men are prone to adopt an arbitrary weight and the replacement is practically never more than relative.

The introduction of the turnbuckle was a distinct departure from the methods in general use. It offered a definite control over the amount of extension and without sacrificing results already attained permitted further adjustment to meet the deformity still present, as shown by the X-ray. The turnbuckle offered, however, was very inadequate to meet the needs of general application. It had unwieldy anchor ends to be imbedded in plaster above and below the fracture. These ends were difficult to make stable even on the femur, and even here were limited practically exclusively to fractures in the middle third. Further, they could give extension but were not satisfactory as to maintenance of alignment and fixation. Torsion of the limb could readily occur.

The four types of splints presented are adapted for use in the fractures

of any of the major long bones of the body. As all parts are interchangeable, many modifications are possible. The splints have conveniences so that the surgeon can build a splint according to the needs of the individual case. It is needful to say that these splints involve a new conception of the treatment of fractures. They make larger demands on the mechanical ingenuity of the surgeon. They also require a greater attention to detail and what might well be called drudgery. The results attained have been striking, and much greater than my expectations, particularly in treating rebellious fractures. In all acute fractures in the continuity of the long bones of the limbs the intelligent application of these splints, while the fractured ends are still free, will bring the parts to their normal relations. The cases to be reported will demonstrate that even in delayed cases most remarkable results have been obtained.

Splint Mechanics.—These splints are all built on the one basic principle—a rigid anchorage above and below the fractures sufficient to bear comfortably all the strain needed to give the requisite extension. Splint arms extend from these fixation supports over the fractured area, overlapping each other to an ample degree. The overlapping arms can be clamped together or slide free in an encircling sleeve. Turnbuckle devices are mountable on these overlapping arms and give the desired extension. When this is gained the arms are clamped tight in the sleeves. Should the X-ray show still further correction is needed, the turnbuckles are remounted, and a definite measured extension to meet the X-ray demands can be made. It is possible to make the correction to a nicety. The fixation is absolute.

It is imperative that the operator learn how to utilize the various parts of the body to meet his mechanical needs. Whether it be the buttock ring and trunk arm of the femur splint, the shoulder girdle of the humerus splint or the various plaster-of-Paris applications, he must study how best to secure the most comfortable and the most complete support. Increased knowledge as to this will come with experience. In an earlier publication (ANNALS OF SURGERY, April, 1921) I advised making the buttock ring several inches over the tape measure circumference to allow for the padding. This was a mistake, as it brought the inner rim on the anterior surface of the pubis. I now make it as near as possible the tape measure circumference. The padding rests more firmly on the soft tissue and the iron bears against the anterolateral aspect of the pubis, a much less irritating position. In the delayed thigh case here reported I used possibly a hundred pounds pressure and yet there was no tissue injury and a quite bearable pressure complaint.

In the application of the plaster the bandages used are comparatively narrow and quite wet, so that the layers will be well incorporated. No padding should be used. The plaster should not be drawn to impair circulation, but should fit the parts intimately. It would be foolhardy to overlook the possible danger of plaster, particularly in forearm fractures. A plaster applied early in forearm fractures will undoubtedly aggravate the later swelling. Most careful attention should be given that the constriction does not

pass safe limits. In severe cases of swelling the case is slit and forcibly sprung open, a cork is placed between the cut edges to maintain the separation. This applies particularly to the plaster on the upper forearm. It can be drawn together as the swelling subsides. Even though it might be necessary to remove the casts, we have gained our reduction, and the retention for the time the plaster was in place. In one of my cases there was an œdema and congestion that prompted me to remove the casts on the fourth day. The tissues under the casts were in good condition and the intervening area of swelling subsided without incident.

To resume, we get support from an increasing circumference and none from a receding circumference. Thus in the leg plaster for a thigh splint, we have support from the knee-joint to the maximum circumference of the calf and none from this point till we reach the swell of the ankle.

Where the edge of the plaster might chafe the skin as on the foot, a small strip of artificial leather laid next the skin and held by the plaster will prevent chafing. Chafing should be guarded against. It should be noted at its beginning and properly corrected.

In the plaster glove for Colles and other forearm fractures, the thumb should be held by the plaster in moderate abduction. This gives a greater wedge-shape to the hand and so gives better support. It would be impossible to note all the little details for the different splints, but these mentioned serve to indicate the thought that should be applied elsewhere.

Case I.—Figs. 1, 2, 3 show the accuracy with which an impacted Colles fracture was brought to normal position. The typical deformity was marked. Care was taken that the small plates were imbedded in the plaster on the dorsum of the hand and in the plaster on the upper forearm in true alignment. The overlapping plates were bent using the well forearm as a model. When these are attached to the imbedded plates, the turnbuckle assembly applied and extension made, the deformity disappears without any pain. The retention is absolute. The pictures show the avantage of complete X-raying. This was the right arm and I extended till the forearm was a shade longer than the left. The X-ray showed still about ⅛ inch impaction. The turnbuckle was reapplied and the perfect reduction of Fig. 3 secured. Convalescence uneventful with perfect restoration.

It cannot be emphasized too strongly that the time to secure perfect replacement is while the bones are freely movable.

Case II.—Figs. 1, 2, 3, 4 show how much benefit can be secured by this plan of treatment even after considerable delay. I saw this case thirteen days after the injury. Fig. 1 shows the comminution (six pieces) and the separation of the parts. The patient was a Pole, thirty-seven years of age, who had no intelligence where discomfort or pain was concerned. He gave the history of having thrown his sand bags and weights on the floor and thrashing over the bed. The deformity was greater than at the time of the injury. The tissue organization that can occur in thirteen days made me pessimistic as to bone union. With the comminution shortening and mental qualities of the patient an open operation was doomed to failure. My hope was to lessen the shortening, improve the alignment, gain bone union of the fragments and later do an open operation on the main shaft ends. The patient was so unmanageable that I had to replace the thumb screws with machine screws tightened with pliers so that he could not loosen them.

FIG. 1.—Case I. Note deformity and impaction.

FIG. 2.—Case I. Impaction not completely reduced.

FIG. 3.—Case I. No impaction and no deformity

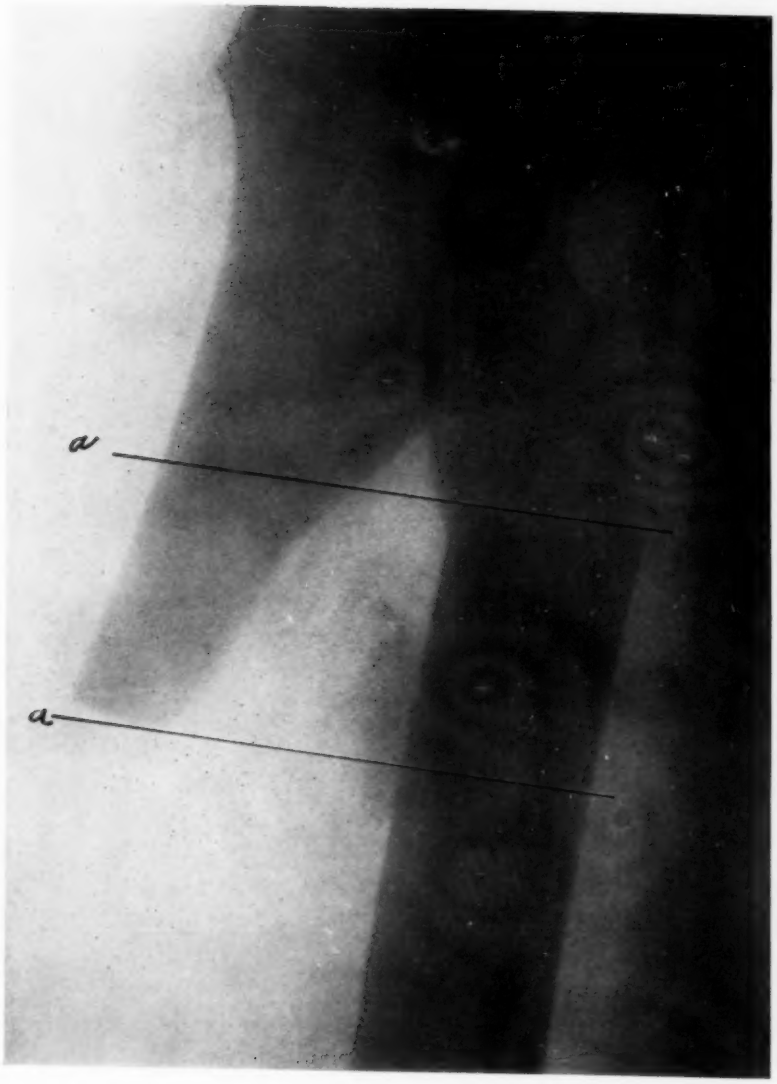

FIG. 4.—Case II. Note the free lying fragments and the angulation. Thirteen days after injury.

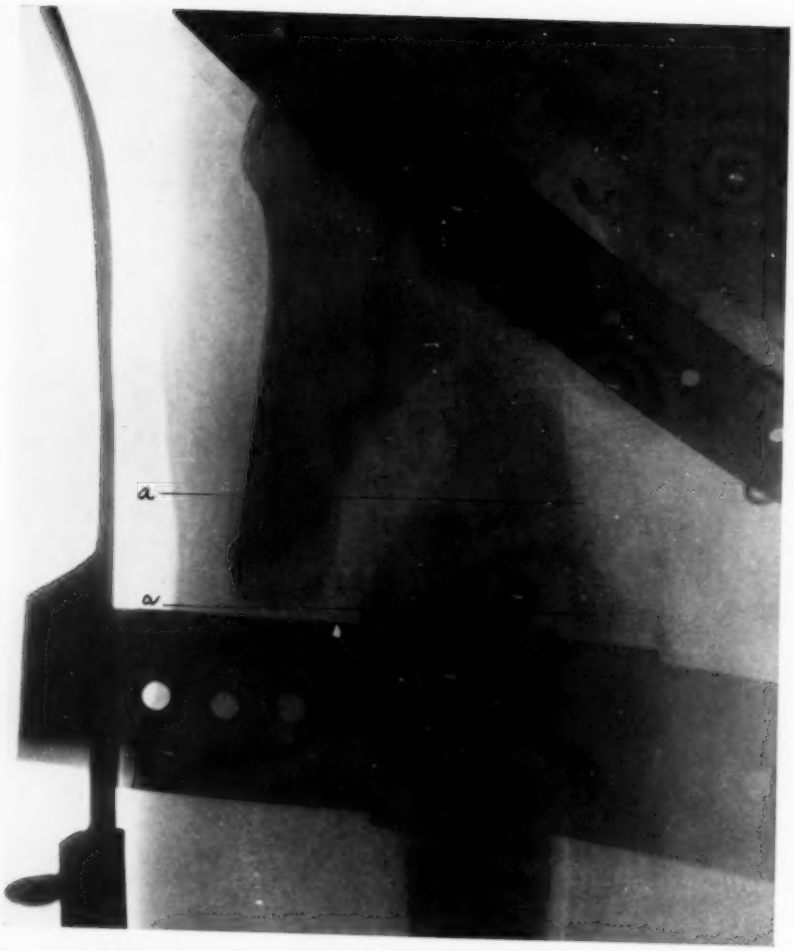

FIG. 5.—Case II. Note closer approximation of the fragments, the better alignment and the reduction of the shortening as shown by parallel lines on Figs. 1 and 2.

FIG. 6.—Case II. Heavy callus and good function.

FIG. 7.—Case II. Lateral view of Fig. 3. Both six weeks after application of Masland splint.

FIG. 8.—Case III. Separation at the time of injury.

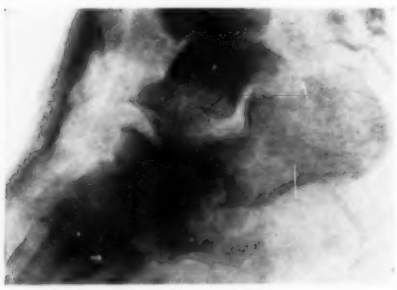

FIG. 9.—Case III. Twenty-three days after injury. No improvement in dislocation.

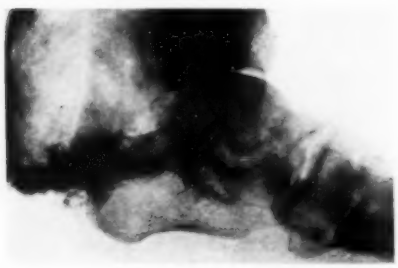

FIG. 10.—Case III. Unfortunately reduction apparatus removed or displaced. Note almost complete reduction of dislocation.

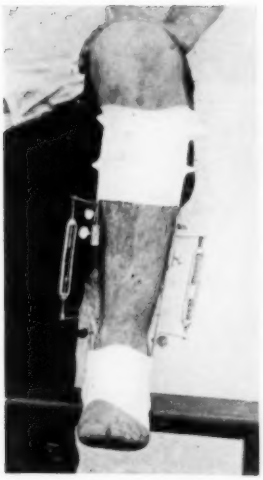

FIG. 11.—For fracture of lower half of leg.

FIG. 12.—Arm splint.

FIG. 13.—For Colles fracture.

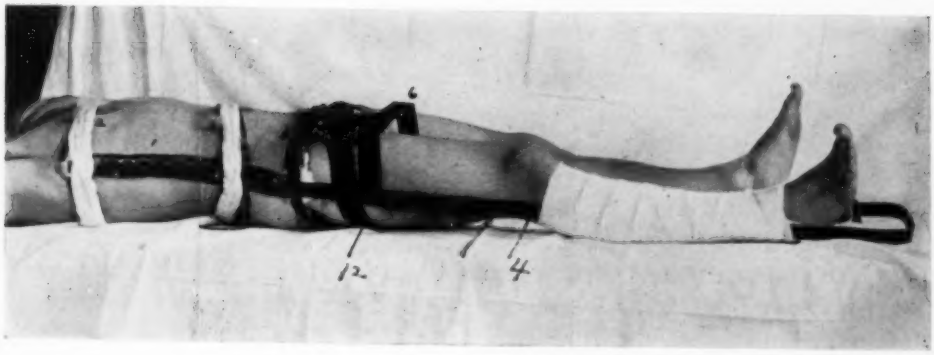

FIG. 14.—Thigh splint.

Only experience could tell me what he could stand. I applied extension to what I felt was the limit. The first leg plaster slipped and started to chafe the tendo Achillis. It was replaced promptly and gave no further trouble. There was no chafing whatsoever from the buttock ring. Only a positive fixation apparatus would have been of any value. The stretch of the tissues after thirteen days in the thick part of the upper thigh as shown by the parallel lines on Figs. 1 and 2 shows the extending power of the turnbuckles. The heavy callus of the union is far from an artistic result, but Nature will mould this to better lines in time and he has a good serviceable limb slightly over an inch short.

While these splints are devised primarily for fractures of the major long bones, the ingenious surgeon will find parts useful in the treatment of other conditions. In fractures of the metatarsals and the metacarpals and some phalangeal fractures single or multiple, two of the smaller strips can be made into a rigid T. The stem is imbedded in plaster on the foot or hand above the fracture and extension made from the cross-arm to the phalanges.

Case III.—Figs. 1, 2, 3 show a rare case of downward dislocation of the scaphoid and cuboid from the astragalus and the os calcis. I saw the case twenty-three days after the injury when Fig. 2 showed no improvement over the original injury. Several thoughts arise from the contemplation of these pictures. We should remember that the force to replace a part with its torn ligaments is not as great as the producing force. This was quite capable of immediate complete replacement. In holding a limb at what we think is the right position and applying plaster how often the X-ray shows a disheartening result. Then it rests with the surgeon whether he will repeat the whole process or conclude that it is the best that can be done. After twenty-three days immediate forcible replacement is impossible as the bone space is filled with new tissue. The benefit to be derived from elastic flexion occurred to me. A plaster sleeve was placed around the leg above the ankles with a posterior projecting piece extending down and around the heel to prevent its forward movement. A shaped iron strap was imbedded in this plaster with the eyeletted ends exposed. A strip similarly shaped to the foot sole was imbedded in plaster around the metatarsals with the ends exposed. Elastic bands on each side producing dorsal flexion to the limit of endurance were stretched between the opposing eyes. These were worn for four weeks with the result as shown in Fig. 3.

The few cases here shown warrant the conclusion that a more painstaking study of traumatic bone lesions, a more thorough grasp of mechanical methods available, and a degree of attention to the details of care of these injuries will yield results far in advance of what is now considered possible. The results of treatment of bone injuries should closely approach those secured in soft tissue injuries.

The great extension power of this splint that can be borne with comfort is better understood when we compare its mechanics with the modern traction table, the most powerful equipment now used. In this table a prop rests against the symphysis pubis. There is sensitive skin in this region and the support is a one-point support to the side of the femur. The other leg must be anchored to prevent undue tilting of the body. The traction is made by a loop around the foot connected with a screw. It is not practicable to

make a band that would press uniformly on the dorsum of the foot and the heel. There is consequent linear pressure on narrow skin areas. I am confident that anything like the traction exerted on this leg would have torn the skin of the foot. In this device the buttock ring fits snugly against the skin throughout its circumference, braced at three points against bone, the pubis, the ischium and the ilium. The femur is in the centre of this ring. The plaster on the leg utilizes every support point from the knee-joint down. There is absolutely no padding, a pernicious thing for this type of mechanics, and the pressure is uniformly distributed.

TRANSACTIONS
OF THE
PHILADELPHIA ACADEMY OF SURGERY

Stated Meeting Held February 6, 1922

The President, Dr. John H. Jopson, in the Chair

BONE TRANSPLANTATION FOR CYST OF TIBIA

Dr. James K. Young presented a young woman, age eighteen, who at the age of six was kicked in the left ankle; two months later the lower end of the tibia was swollen. No surgical treatment until three years ago, when patient was operated on, the lower end of tibia being scraped. She came under the reporter's observation three years ago. X-ray showed a bone cyst of the lower end of the tibia. She was subjected to operation June 5, 1920, at the Polyclinic Hospital. The cortex of the tibia was found thinned out, resembling an egg-shell. Wall lined with thick capsules. The walls of the tibia were equally distended in all directions. A bone-graft from the opposite tibia was implanted. There was no post-operative hemorrhage and no pain since operation. One year after the first operation, the tendo Achillis was subcutaneously divided. Since that time there has been a perfect result. Recent X-rays show the bone transplant in place.

DISARTICULATION OF THE HIP-JOINT FOR PERIOSTEAL SARCOMA

Doctor Young presented a boy, aged sixteen years, who was admitted to hospital December 15, 1920, for pain in knee. No history of trauma. When operated upon, January 10, 1921, periosteal sarcoma was found in the middle of left femur involving the soft parts and the shaft above the internal condyle. Complete disarticulation of hip and amputation was done. Assisted at operation by Doctors Elmer and Cooperman. Laboratory diagnosis: spindle-cell sarcoma, some giant-cells, extensive necrosis, some highly malignant cells. Examination of the lung, November 8, 1921, no evidence of metastatic sarcoma, no evidence of disease about the shoulder-joint. On account of malignancy one tourniquet was applied at the upper border of the tumor, a long rubber tube was also applied above the pins. The femur was sawed off below the trochanter; amputation, no deep sutures were used. The time of operation was reduced, patient had no shock at operation, but two and a half hours later he had shock, but after the first six hours his convalescence was uneventful. He is now in perfect health.

Dr. A. P. C. Ashhurst asked why Doctor Young sawed the diseased bone through first and then enucleated the upper end, instead of taking it out in one piece. By Doctor Young's procedure there was danger of contamination of the wound; his own experience had been that in patients where there is danger of spreading infection, tumors, or gas gangrene, it

was better not to use the Esmarch band, but to amputate by dissection. This was not as hard as it seemed, if one cuts down anteriorly, then ligates the common femoral, just below Poupart's ligament, and then ligates the superficial and deep femoral just below and divides the arteries between the ligatures. If the patient is kept in the Trendelenburg position all this time, the venous blood will run down the limb into the trunk. The common femoral vein can then be ligated and the joint opened. Then, as to diagnosis, there were some things he would like to ask. As to the diagnosis of "spindle-cell sarcoma," there were some sceptics like Bloodgood, Ewing and Codman, who have been making a registry of all these bone sarcomas. They want reports of all cases of bone sarcoma that are now alive; they want sections sent them, X-ray reports, etc., and they supply a form which can be filled out and which gives them the information they desire. He desired to know whether these observers agreed with Doctor Young that this was really a case of sarcoma.

Doctor Young replied that he had sent all the information mentioned to Dr. E. A. Codman, of Boston, that a slide had been sent, also a specimen. He sawed through the bone first because he thought it simplified the operation considerably. He has always been impressed with the great ease and safety of the secondary operation, *i.e.*, secondary amputation of the hip-joint, which he believes is far superior to the primary amputation. He remembers the paper of Morton, published in the transactions of the Pennsylvania Hospital, with photographs of three patients sitting side by side, each having had amputation of the hip-joint. He was impressed when he found out that these were all secondary amputations. It is the removal of the bone which gives the shock; if one can divide the operation in two, it shortens the time of operation and diminishes the shock. In regard to spreading malignancy, he tried to prevent this by using the extra Esmarch band, which saves a little blood; also the long tube above the pin was very satisfactory. He thought the ideal operation to be amputation high, dividing the bone, and then disarticulating.

At one time since operation patient had tuberculosis of one lung. He spent a number of months in the pines of New Jersey, since which time there had been no evidence of the disease.

WILLEM'S TREATMENT OF SEPTIC KNEES

Dr. Morris Booth Miller presented a man, thirty years of age, who about thirteen months ago ran a needle into the outer surface of the leg, just below the knee-joint. The needle was broken off. In the attempts to remove it the wound became infected, and a few days later the joint surfaces became involved in a streptococcic infection of considerable severity. The treatment consisted of bilateral free incisions into the joint followed by systematic mobilization. He was in the hospital about three months. The case is presented as showing perfect functional recovery. There is full range of motion, full strength of the limb, and no resulting painful phenomena.

RESECTION OF THE SMALL BOWEL FOLLOWING A GUNSHOT INJURY

Dr. W. Estell Lee reported the case of a boy, fifteen years of age, who was admitted to the Pennsylvania Hospital, January 1, 1922, complaining of a bullet wound of the abdomen.

On the anterior wall of the abdomen there was a small bullet wound about two cm. to the left and one cm. below the umbilicus which traversed the left rectus muscle. The abdomen was quite tender in this region, but there was no definite rigidity. No peristaltic movements could be heard by auscultation. There were no evidences of either free fluid or air in the peritoneal cavity.

The boy was not uncomfortable and there were no definite signs of shock. Three hours after the accident had occurred, an exploratory laparotomy was done by Doctor Lee.

A modified left rectus incision was used, excising the track in its central portion. On opening the peritoneal cavity a small loop of gut which was directly underlying the penetrating bullet wound was exposed. It proved to be a portion of the ileum in about its middle third. In this loop a total of eight perforations had occurred all within the distance of seven inches. Most of the perforations had been fairly well walled off by omentum and there was little or no soiling of the peritoneal surfaces. No other injury to the bowel or other viscera was found and the bullet wound of exit from the peritoneal cavity was not located.

Resection of this portion of perforated gut was done. A piece of ileum twelve inches in length was removed and an end-to-end anastomosis done. The abdomen was closed without drainage.

Subsequent Course.—One week following the operation the boy started to run some temperature and shortly afterwards a small mass developed directly beneath the operative incision. This was opened and a small amount of pus evacuated. Apart from this, his recovery was uneventful and fairly rapid. He was discharged from the hospital in good condition twenty-five days after admission.

SPONTANEOUS LATERAL VENTRAL HERNIA

Dr. Jackson K. Holloway read a paper with the above title, for which see vol. lxxv, page 677.

HARELIP AND CLEFT PALATE DEFORMITIES

Dr. W. B. Davis read a paper on the above subject, for which see August number Annals of Surgery.

Dr. John B. Roberts, in discussing Doctor Davis' paper on harelip and cleft palate deformities, approved of early operative treatment, followed by careful training in speech by some one experienced in developing the proper use of the palatal and pharyngeal muscles. A long period of such instruction by the mother aiding the teacher may result in overcoming to a considerable extent the disability, due to the shortness of the soft palate even after the cleft is closed by operation. This will occupy years and should be started in infancy. He would like to have heard Doctor Davis tell how he closed the double clefts of soft and hard palate and lips. These are

the cases which have given Doctor Roberts great trouble. He usually closes first the alveolar process with wire and later the lip with silkworm gut. He is rather inclined to leave the palate itself until the child is a few months old, using then for the hard palate the Langenbeck method, the Lane upset-flap method or modifications of these operations. It is essential to separate from the posterior edge of the hard palate the nasal mucosa and the fibrous sheet of attachment, to let the velum drop towards the tongue.

The parents dislike the conspicuous part of the deformity so much that he likes to get the nose, lip and alveolus corrected early, even if they will require subsequent modelling later.

The protrusion of the intermaxillary bone should be corrected first of all in complicated clefts of lip and palate. This usually requires osteoplastic

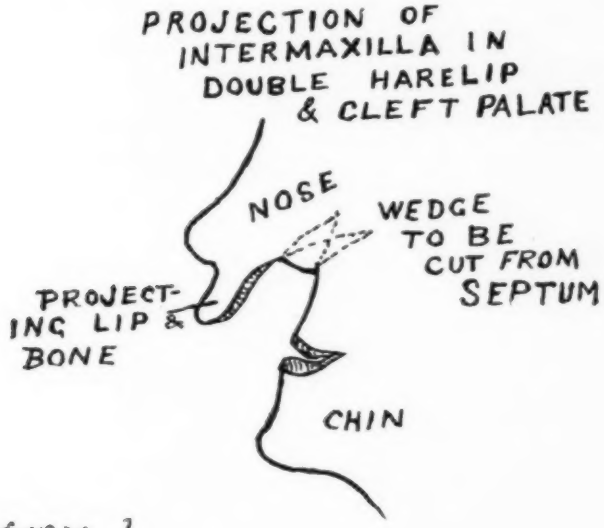

Diagram 1
Replacement of Intermaxilla.

replacement. The intermaxilla should never be removed; it must be retained and replaced to restore the dental arch.

When the hard palate is closed there is sometimes left a small opening behind the incisor teeth running from the mouth into the nose. Lane, he believes, sometimes anticipates this event by allowing the pieces trimmed from the edges of the labial cleft attached at the nostril. These two strips are turned under the lip of the baby, sutured together, and tucked up to close the floor of the nostril back of the incisor teeth. The fissure in the upper lip is then sutured; and the small nodule behind it is of service, when the uranoplasty is performed later to close the roof of the mouth.

Doctor Roberts with lantern slides then showed irregular methods of making flaps and closing the hard palate. These he had found useful in his own work.

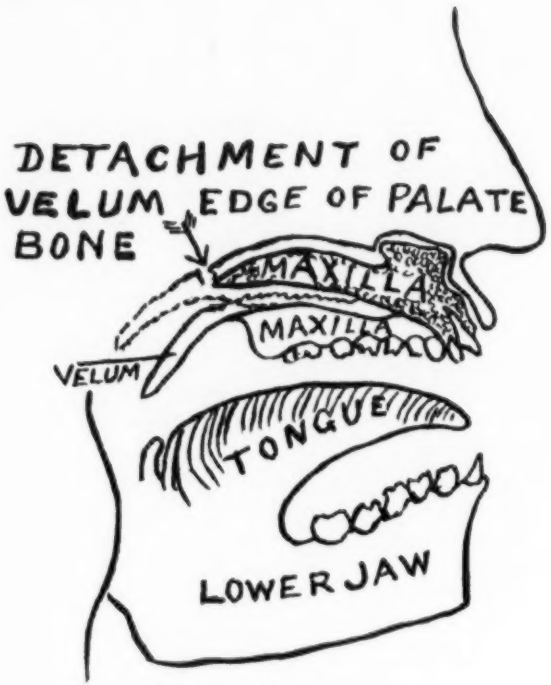

Diagram 2
Cutting Velum from Edge of Palate Bone

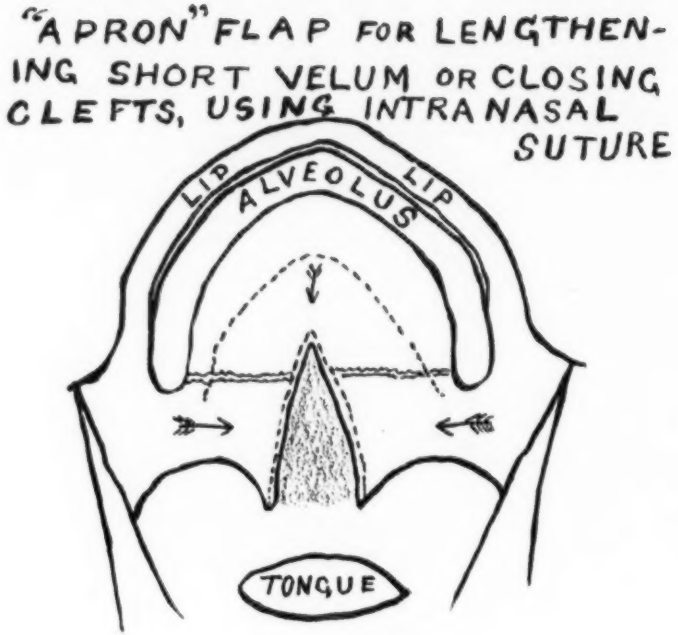

Diagram 3
Incisions for Double Cleft of Velum.

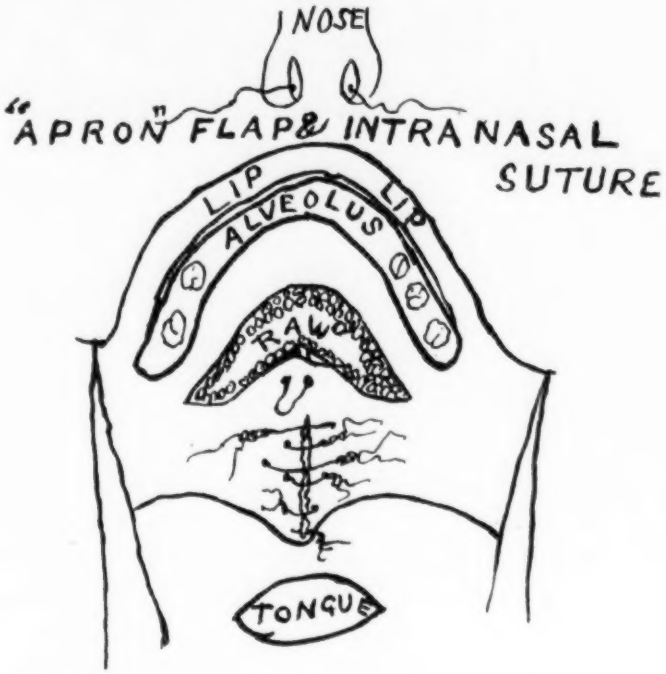

Diagram 4
Operation for Double Cleft of Velum

An Unusual or "BRIDGE" CLOSURE WITH ANTERIOR AND POSTERIOR FLAPS

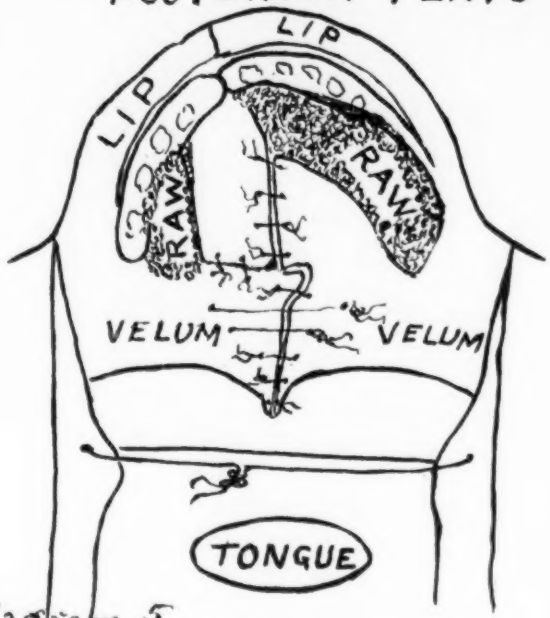

Diagram 5
Closure of a Right Cleft

TRANSACTIONS
OF THE
NEW YORK SURGICAL SOCIETY

Stated Meeting Held March 8, 1922

The Vice President, Dr. Eugene H. Pool, in the Chair

THE FORMATION OF A THUMB FROM THE FIRST METACARPUS

Dr. H. H. M. Lyle presented a man who was first admitted to his service at St. Luke's Hospital, January 6, 1913. He was then nine years of age, and a wheel of a trolley car had run over his hand (Fig. 1). He was shown before this Society in 1914. (See Annals of Surgery, vol. lix, May, 1914, p. 767.) Shortly after demonstrating this case to the Society, and before the plastic work on the hand was finished to the surgeon's satisfaction, he moved to Chicago. Three weeks ago he returned to New York and again came under observation. He tells that he used the hand steadily, and that he is a professional chauffeur.

A comparison of the photographs (Figs. 1, 2, 3, and 4) shows that there has been considerable functional and anatomical improvement from the report of nine years ago. The original X-ray (Fig. 1) shows, besides other serious injuries, a separation of the epiphysial cartilage of the first metacarpal. On the X-ray (Fig. 3), taken two weeks ago, the metacarpus now looks normal. When he left New York nine years ago an excision of the excess of fat from the dorsal flap that had been grafted from the abdomen was planned. On his return two weeks ago, this original plan was carried out. The power of grasp which he now has is very gratifying. In addition, Doctor Lyle exhibited photographs of two other similar cases, and referred to a fourth, in which a stub of a metacarpus was developed into a useful thumb.

THE TREATMENT OF HAND CONTRACTURE

Dr. H. H. M. Lyle presented a man who entered his service at St. Luke's Hospital, March 22, 1921. Six months previously he had been struck on the back of the right hand by a brick, and sustained a lacerated wound on the dorsum of the hand. He entered a Sister hospital, where his extensor tendons were sutured; the wound became infected, and he was told that three of his tendons had sloughed out. The wound healed in two months, the hand was stiff and painful, and he could not flex any of his fingers. He was treated for four months with massage, baking and hydrotherapy, without any appreciable result. He was then referred to St. Luke's. Figure 6 shows the condition of the hand on admission. The wrist can be slightly flexed; no flexion possible at metacarpo-phalangeal, or at first interphalangeal joints. The thumb cannot be apposed to other fingers; slight flexion of terminal phalanges. There is wide, transverse, adherent,

FIG. 1.—X-ray of original injury, June 6, 1913. Note the damage to the epiphysial cartilage of the metacarpus.

FIG. 2.—Condition of hand showing the formation of a new thumb. July, 1913. Soft tissue has been grafted from abdomen.

FIG. 3.—X-ray of hand nine years later. Note that the metacarpus has developed greatly.

FIGS. 4 and 5.—Show result after nine years of functional use.

FIGS. 8 and 9.—Show the functional results obtained.

FIG. 6.—Condition of hand on admission. The fingers are fixed in the position shown.

FIG. 7.—Shows palmar aspect of cast cut away and the method of inserting the felt wedges between the beak of the cast and the first phalanges. Complete flexion at the metacarpo-phalangeal joints has been obtained.

paper-like scar just above the wrist, into this pass the atrophied extensor tendons of the fingers. Over the radius there is a deep adherent longitudinal scar. Patient says this was the result of a drainage incision. The flexor tendons are intact. There are no nerve lesions present. The picture is that of a painful, stiff and useless hand.

The interest lies in the fact that this case presents some of the common sequelæ of injuries associated with infection. From the rich material that the war furnished us, surgery has been able to draw valuable conclusions regarding the immediate and after-treatment of wounds. It is our duty to apply these lessons to the injuries of civil life. An examination revealed the following conditions. There was partial ankylosis of the wrist, due to fibrous adhesions; the extensor tendons of the wrist were shortened and adherent to a mass of scar tissue. There was marked damage to the extensor tendons of thumb. Flexion at the metacarpo-phalangeal joints was impossible, due to the shortening of the extensor tendons and the fibrous thickening of the metacarpo-phalangeal capsules. To overcome these difficulties, the following course of treatment was outlined:

(1) The breaking up of as many as possible of the adhesions in the wrist, tendons and joint capsules. (2) The fixation of the wrist in dorsi-flexion. (3) The gradual flexion of metacarpo-phalangeal joints, with the corresponding stretching of the extensor tendons. (4) The tendons to be freed when the maximum amount of function has been obtained by conservative means. (5) The functional re-education of the hand.

On March 22, 1921, under ether. The wrist, finger joints, and tendons were mobilized as much as possible by manipulation, a moderate dorsi-flexion of the wrist with a slight flexion of the metacarpo-phalangeal joints was obtained. The hand and forearm was then put up in plaster. On the palmar side the case extended from above the elbow to the heads of the metacarpals on the dorsum from above the elbow, over wrist and fingers and back up on the palmar surface to the wrist. This enclosed the hand. When the case was sufficiently set, the portion of the palmar surface of the case in relation to the fingers was cut away. Wedges of piano felt were inserted between the dorsum of the distal portion of the metacarpals and the overlying beak of the case (Fig. 7). The leverage being applied so that the metacarpo-phalangeal joint surface would be separated and the capsule stretched. Additional wedges were added as required. The metacarpals were completely flexed in three weeks. As wedging was no longer necessary, the beak of the case was removed, and spring traction was made from above the elbow to a padded bar applied over the distal portion of the metacarpals. In this manner the same force was applied, but the additional advantage of massage and movements of terminal phalanges were obtained. The case was removed two weeks later, and spring traction was taken from a cuff on the arm to the padded bar over the metacarpals. By April 13th, the patient began to develop a light grasp. When the patient began to voluntarily flex the joints and could retain the flexion, the apparatus was removed during the day-time, but applied at night. Systematic

FIG. 10.—Chordoma (sacro-coccygeal).

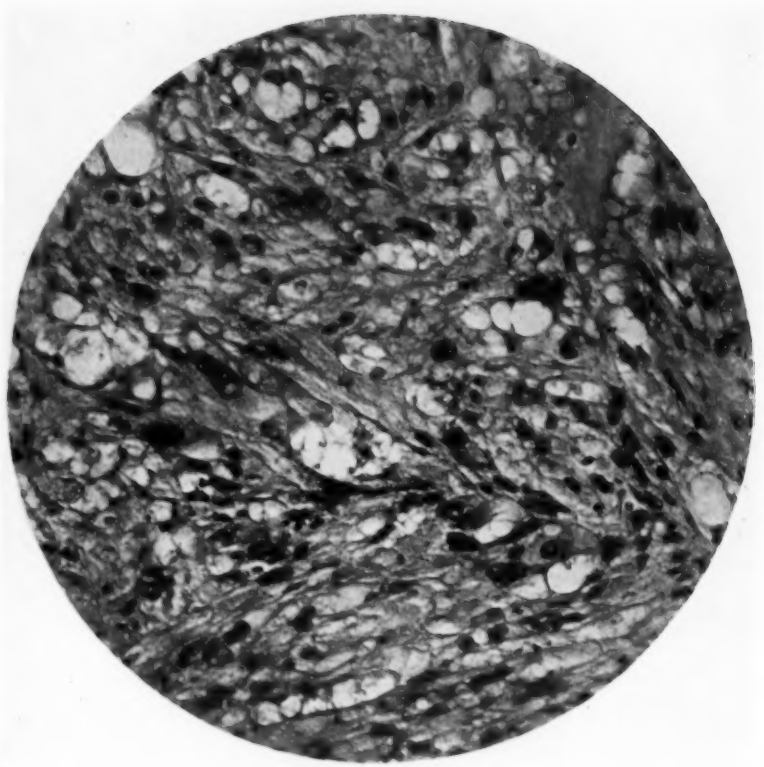

FIG. 11.—Chordoma (sacro-coccygeal).

exercises and occupational therapy were vigorously carried out. In June the tendons were freed from the skin and from the deeper parts. This resulted in a slight improvement. You will note that the patient can make the firmest kind of a fist, and can swing a heavy hammer. Figures 8 and 9 show the functional result obtained. The elaboration of this method of treatment is due to Dixon, of England.

WHEELER SKIN-GRAFTING OPERATION APPLIED TO AN EXCISION OF AN EPITHELIOMA OF LOWER EYELID

DR. H. H. M. LYLE presented a man who was admitted to his service at the Skin and Cancer Hospital, with a moderate-sized basal-cell epithelioma of the lower lid. He first noticed it two years ago. Lately it has begun to grow more rapidly. The growth, with the skin of the lower eyelid, was excised, and the defect in the lower lid filled by a graft taken from the upper lid, and the eyelids sutured together. The method and technic was that originated by J. Wheeler, of New York. This patient was operated on thirty-seven days ago, and was shown in order that the society might observe the progress of the case. He will be shown again after the period of maximum contraction has passed. It will be noted that the defect in the upper eyelid is almost invisible, and the graft in the lower lid can hardly be distinguished from the surrounding tissue. For the details of the operation and after-care, the Society is referred to Wheeler's article, J. A. M. A., November, 1921, page 1628.

SACRO-COCCYGEAL CHORDOMA

DR. EUGENE H. POOL presented a case of chordoma because the lesion is rare, yet one should ordinarily recognize the condition clinically. Chordoma arises from a remnant of the notochord and occurs usually at the base of the skull or in the sacro-coccygeal region. It is composed of peculiar vacuolated cells. N. D. C. Lewis has recently reported four cases (*Archives of Internal Medicine*, 1921, vol. xxviii, p. 434). F. B. Lund (*Boston Medical and Surgical Journal*, 1919, vol. clxxx, p. 708), and H. Albert (*Surgery, Gynecology and Obstetrics*, 1915, vol. xxi, p. 766), have also contributed cases.

The patient, a woman, sixty-five years old, was admitted to the New York Hospital, June, 1921; she had experienced steady increasingly intense pain in the sacral region for two years. Three months before she felt a mass per vagina. Menopause fifteen years ago and has had no bleeding since. No blood by rectum but was very constipated. Also had frequency and urgency of micturition, with nocturia four times. Past history negative. There was no weakness or loss of weight.

Examination showed fairly well-nourished woman. Thorax and abdomen negative. In the sacro-coccygeal region, palpated through the posterior wall of the rectum, was a hard, circumscribed, slightly nodular mass about three inches in diameter, broadly attached to the sacrum and giving an egg-shell crackle on surface.

As the pain had become unbearable palliative operation was decided

upon, the broad attachment and involvement of the sacrum making a radical operation imposible. Radium was not advised on account of danger to bladder and rectum.

Sagittal incision with removal of coccyx. The coccyx and sacrum were found to be infiltrated by a soft neoplasm extending upward and forward for three inches, forming a broken-down mass with rather dense walls, in which were fragments of the bone which had been separated from the sacrum. Rectum not involved. The growth evidently originated within the sacrum. It was removed as completely as possible. Wound packed and left partially open for radium therapy. Considerable hemorrhage resulted and six hours later she was transfused. The patient was transferred to General Memorial Hospital, fifteen days post-operative, where she received radium therapy. For some months patient was relieved of pain. Returned to New York Hospital March 2, 1922, with a recurrence of pain in sacral region and a rounded tumor about two and one-half inches in diameter palpable through posterior rectal wall, evidently a recurrence of the tumor in the original location. There is no evidence of metastases, although complete fluoroscopic examination has been made.

Apparently these sacro-coccygeal chordomas regularly occur in the hollow of the sacrum; according to Lewis they infrequently give rise to metastases but infiltrate widely and have proved 100 per cent. fatal.

Pathological Report by Doctor Müller.—Specimen consists of a mass of soft crumbly material five cm. in diameter, and a piece of bone (coccyx) to which a quantity of similar material is attached.

Microscopical.—(Figs. 10 and 11.) The cell outlines are very indistinct and the general picture is that of vacuolated syncytial tissue having a tendency to stain blue with hæmatoxylin. This blue stain suggests the presence of mucin. The nuclei vary much in size and shape, but most are large oval nuclei with abundant finely granular, closely packed chromatin material. In many nuclei a nucleolus is visible. Some nuclei are distinctly hyperchromatic. The vacuoles in the syncytium, which are perfectly clear, are very numerous, mostly round, and vary in size up to the size of an adult fat cell. A few small spicules of bone are present in some sections. Bands of connective tissue with round-cell infiltration divide the tissue up into pinhead-sized lobules.

PLASTIC OPERATION ON LEG

Dr. Eugene H. Pool presented a case which, although it might appear too trivial to present, seemed to involve a principle which might prove of some value for covering large defects over the flexor surfaces of elbow or knee. Especially in a child, a large pedunculated flap to cover such a defect is not only difficult to secure, but considerable additional scarring must result; Thiersch grafts in these positions are likely to result in contraction. The procedure employed in this case was to throw a bridge of healthy skin across the centre of the granulating area corresponding approximately to the flexure of the knee. The much reduced granulating areas above and below may be

covered with Thiersch's grafts, the transverse bridge of normal skin preventing contraction of the cicatrix.

The procedure as applied in this case was as follows:

The patient was a girl four years of age. As the result of an automobile accident there was a large infected wound with loss of superficial soft parts over the popliteal space. On admission there was a granulating area over the popliteal space six by four inches. Around the upper part of the wound and about one inch from its edge an incision was made so that a flap was raised attached at its ends on each side of the granulating area. It was lifted with the subcutaneous tissues and was readily swung downward across the flexure of the knee, where it was sutured with a few fine chromic stitches. The leg was put up in extension. The upper angle from which the upper part of the flap was removed was approximated by sutures. A small part of the middle of the graft sloughed, but the remaining parts of the flaps could be brought together with adhesive and formed a bridge across the denuded area. In another case Doctor Pool said he should simply bring over a flap from each side and fix them as a bridge with sutures and adhesive; also making the bridge conform more closely to the flexure of joint. Subsequently Thiersch grafts were placed upon the granulating areas above and below the cutaneous bridge. The result has been thoroughly satisfactory.

DUODENAL DIVERTICULA

Dr. William A. Downes read a paper with the above title, for which see page 43.

Dr. John F. Erdmann said he had had two of these cases, one four years ago and one five years ago. Both were diagnosed as diverticulum cases by X-ray and both were operated upon. In neither one of the two was there a chain of symptoms expressive of anything clear. It could not be said they were improved by operation. The first was on the inner, *i.e.*, pancreatic, aspect of the first portion of the duodenum and about the size of a large prune. That of the second patient was on the antero-internal aspect of the first portion of the duodenum and almost twice the size of the first. They were both in females, one about fifty and the other about fifty-five years of age. No difficulty was present in any stage of the operation and both made early and satisfactory recovery.

Dr. Edward W. Peterson said that he had operated upon one case of duodenal diverticulum. The patient, a man of about sixty years, was sent to him by Doctor Page, of White Plains. A preliminary diagnosis of carcinoma of stomach was made, but Doctor Myers, of the Post-graduate X-ray Department, found no evidence of a new growth or of ulceration in the stomach or intestinal tract. There was present, however, a diverticulum of the second portion of the duodenum. At operation the diverticulum was located and removed without any difficulty. The patient also had a gall-bladder filled with stones, for which a cholecystectomy was done. This latter

FIG. 12.—Granulating wound of popliteal space.

FIG. 13.—Flap from each side across flexure of knee (healed in place).

FIG. 14.—Final result showing transverse bridge of normal skin. Areas above and below covered with Thiersch grafts.

FIG. 15.—Final results.

condition probably accounted for the marked digestive disturbances, which had suggested malignancy. The man had lost his wife but a short time before and was decidedly melancholic. He expressed a wish to die. He was discharged from the hospital, but did not improve, and about three months later was admitted to the medical service of the hospital. In spite of the most careful and thorough study no pathological condition was ever diagnosticated. He progressively grew worse and finally died, with the cause of death never satisfactorily explained.

Doctor Downes said that in the great majority of these cases the diverticulum was an accidental finding without symptoms and did not require operation. In the two cases he operated upon there was nothing else to account for the periodic attacks of diarrhœa and for the acute dilatation of the stomach. He considered that operation had been the proper procedure in these cases for they were both relieved as a consequence.

CHRONIC ARTHRITIS OF KNEE-JOINT, GONOCOCCUS BACTERIÆMIA, SUBACUTE GONOCOCCUS ENDOCARDITIS, INFARCT OF SPLEEN

Dr. Ransom S. Hooker presented a girl sixteen years old, who was admitted to the First Surgical Division, Bellevue Hospital, November 28, 1921, with a swollen and painful knee, of fifteen days' duration. She had always been well except between the ages of eight and twelve, when she had pain over heart and difficulty in breathing. At present she has no precordial pain, œdema, or dyspnœa.

Physical examination of heart shows mitral stenosis and insufficiency with cardiac hypertrophy and dilatation.

Patient's temperature on admission was 101°, pulse 104, respiration twenty. Urine normal except for faint trace of albumen. Leucocytes 11,200, polymorphonuclears eighty-two per cent.

X-ray shows "moderate effusion into the left knee-joint and suprapatellar bursa. The joint space is of moderate width. There is a small area of necrosis on the articular surface of the inner condyle of the tibia."

Vaginal examination showed the uterus and adnexa apparently normal. Slight discharge from cervix. Cultures and slides from cervix and vagina, negative for gonococcus.

During the following seventy-seven days patient's temperature fluctuated daily about two degrees on the average, running between 100° and 104°. Repeated blood cultures were taken which showed no growth until, on the sixty-third day, gonococci were found.

No operation was performed on the knee, as this condition did not seem to be progressive and was thought to be peri-articular. The knee was immobilized, followed by cessation of pain shortly after admission. It was believed that the patient had a bacterial endocarditis. At no time were gonococci found in cervix or vagina.

On her seventy-third day she died and autopsy findings were as follows:

Chronic productive mitral and aortic valvulitis. Acute vegetative

mitral valvulitis. Acute verrucous aortic valvulitis. Slight hypertrophy and dilatation of heart. Œdema of lungs. Bilateral hydrothorax. Chronic passive congestion of liver. Chronic septic splenitis. Infarcts of spleen with localized perisplenitis. Localized acute fibrino-purulent peritonitis (in the cul-de-sac of Douglas). Chronic gonococcus? arthritis (left knee-joint). Cervical erosions. Ascites.

Post-mortem, microscopic findings: Chronic passive congestion of lungs. Subacute suppurative peritonitis with granulation tissue. Infarct of spleen. Acute glomerular nephritis. At post-mortem bacteriological examination of heart valve, gonococci were found. Staphylococcus aureus from the spleen.

BOOK REVIEW

SURGICAL DIAGNOSIS AND TREATMENT. By American Authors. Edited by ALBERT J. OCHSNER, M.D., LL.D. 4 vols, octavo cloth, pp. 850, 861, 1018 and 972. Lea and Febiger, Philadelphia.

These four great volumes again illustrate the activity, earnestness and progressiveness of the American surgeons of to-day. Assembled by the distinguished editor seventy-three of his colleagues have joined with him to produce this work, which is intended to give the last word in the field of surgical diagnosis and treatment.

As we read the list of contributors, we are struck with the large number of them who are Fellows of the American Surgical Association, which means that they are men who have long been recognized as leaders among American surgeons. This means also that they speak with authority, and that the reader is consulting the work of one who has both judgment and experience. As showing the uncertainty of life and the transitoriness of position once attained, one is pained to find in this list the names of at least three surgeons who had died before their contribution was published. These are McKenzie, of Portland, Oregon; Ransohoff, of Cincinnati, and Rodman, of Philadelphia. The chapters left by these men in these works will be treasured as their final contributions to the science, which each of them had done so much to enrich.

The editor in the preface of the first volume dwells on the fact that the professional careers of the present leaders in surgery represent a period of advance in methods of diagnosis and treatment unequalled by the progress of many previous centuries. He goes on to say that this particular work is intended to reflect in every sense the current practice and thought of the most intensely active surgeons of this continent. As each succeeding volume has made its appearance, it has been apparent that its contents continue to fairly justify the original expectations of the editor, and the sum total is most helpful and satisfactory to the eager surgeon who resorts to it for counsel. The series of volumes begins with a chapter on Surgical Prognosis. The last chapter of the last volume is devoted to a discussion of the problems involved in the construction of a surgical hospital. In the intervening chapters from start to finish are found discussions by master surgeons of every possible question of diagnosis and treatment presented in the surgery of the twentieth century.

LEWIS S. PILCHER.

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